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Duvernay East Shale Basin

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The Devonian Duvernay Formation in Alberta, Canada, extended from the Peace River Arch in the north all the way to the Eastern Shelf carbonate platform and the Killam Barrier Reef in the south. The basin was bounded to the east by the Grosmont Shelf and to the west by several Leduc reef complexes, with one extensive and elongate reef complex trend (Rimbey-Meadowbrook Reef trend) in the southern part that divided the basin into two major basins (West Shale and East Shale Basin). The Rimbey-Meadowbrook barrier reef system restricted water and sediment exchange between the two basins. Here we discuss the data from the Antelope Twining 100/08-29-031-23W4/00 core located in the southeastern part of the East Shale Basin and illustrate details about depositional changes.

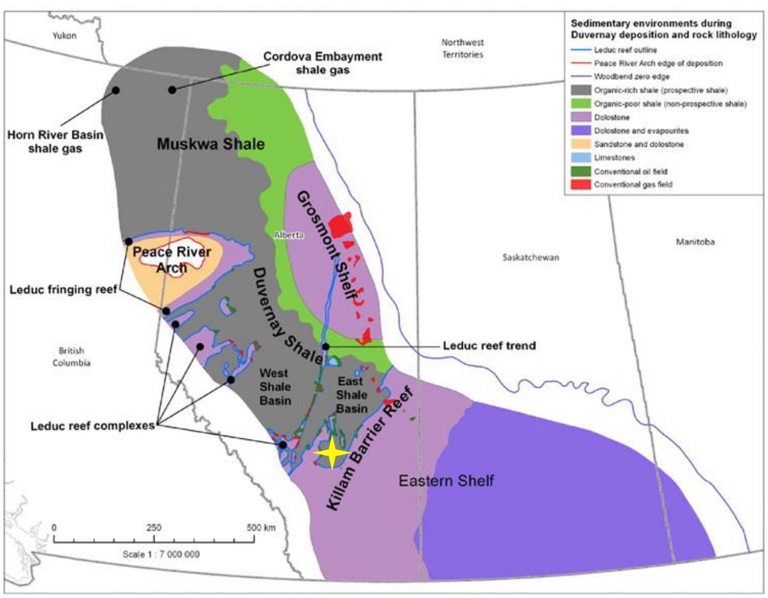

Figure 0-1: Generalized map of the Devonian Duvernay Shale Basin that is divided by the Rimbey-Meadowbrook barrier reef into a West and East Shale Basin. Location of the Antelope Twining 100/08-29-031-23W4/00 core is indicated. Map is adapted from NEB (2017).

The discussion will focus on the challenges associated with the exploration of the unconventional reservoir in the East Shale Basin. The core sections on display are analyzed for porosity, permeability, mineralogy, organic matter composition, maturity and stratigraphic details that give insights into the matrix and diagenetic makings of these rocks.

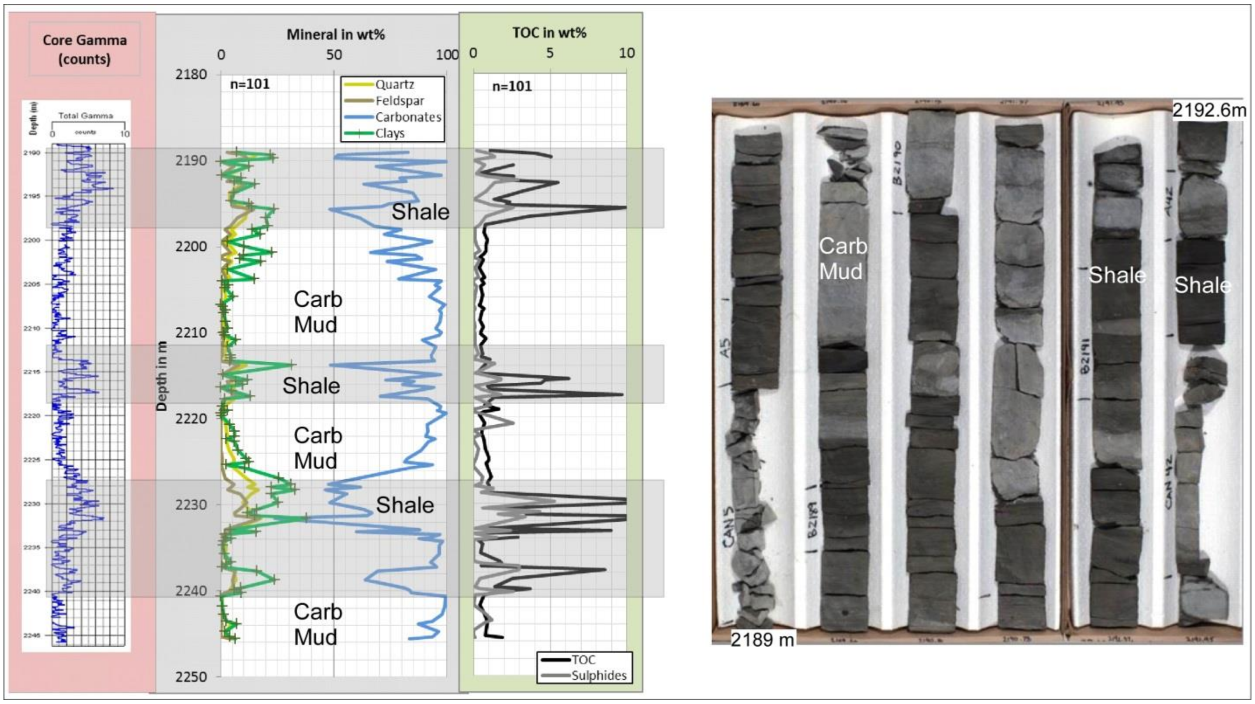

Figure 0-2: Core gamma and mineralogical and organic content variability of the Twining 100/08-29-031-23W4/00 core in the East Shale Basin showing high amounts of carbonate muds throughout the depositional sequence. Within the upper shale package, multiple thin bituminous shales with TOC up to 13 wt-% are interbedded with carbonate mudstones. An example is provided on the right where core depth 2189.00 - 2192.60 m is displayed. From Wust et al. (2018).

High resolution modeling of the core, based on core and log data, identifies highly variable lithology and two primary carbonate units with distinct pore characteristics. The slight differences in properties of these carbonate units influence both mechanical strength as well as fluid saturations. These paramters are critical with respect tothe understanding of the hydraulic fracturing and hydrocarbon production. One of the types of limestone identified is dense with low porosity and another is bituminous, porous and slightly a resistive unit. The units are illustrated in Figure 3 and contain both petrographic and scanning electron microscopy images. The microscopic data show that the rocks are particularely fine-grained with very fine-silt to clay-size particles. Abundant euhedral grain shapes indicates a pervasive diagenetic alteration of the sediments during burial. Discussions will also touch on fracturing and natural fracture networks as well as stimulation challenges.

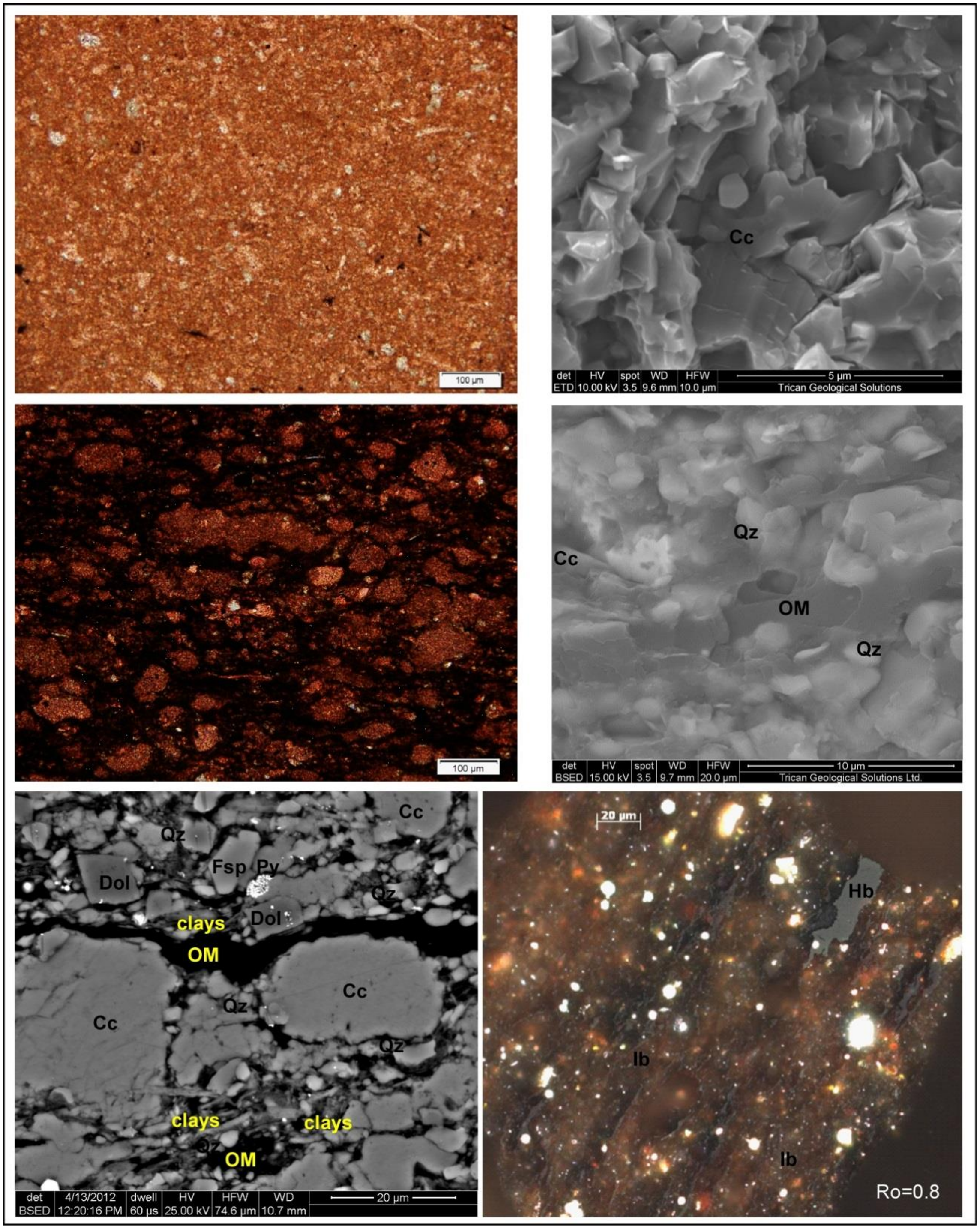

Figure 3: Thin section (left) and SEM (right) micrographs showing details of the carbonate mudstones (top) and the bituminous calcareous shales (middle). The images illustrate the fine-grained nature of these rocks and the pervasive organic matter (non-porous bitumen in the right image) within the shales. Note the abundance of bitumen that occurs in a bimodal reflectance distribution (bottom right). A higher reflectance population has a homogenous reflecting surface (Hb) and occurs in larger accumulations; the lower reflectance population is inhomogeneous (Ib), more abundant and more disseminated. From Wust et al. (2018).

References

National Energy Board, 2017 (NEB) https://www.neb-one.gc.ca/nrg/sttstc/crdlndptrlmprdct/rprt/2017dvrn/index-eng.html

Wüst, R. A. J., Mattucci, M., Hawkes, R., Quintero, H., & Sessarego, S. (2018, October 16). Early Insights from Various Load Fluid Recoveries after Hydraulic Fracturing Treatments: A Case History of a Developing Unconventional Oil Shale Play in Alberta. Society of Petroleum Engineers. doi:10.2118/191421-18IHFT-MS