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Sedimentological and Stratigraphic Observations from the Margin-to-Basin system of The Duvernay Formation: 'A Field Notebook is Worth a Thousand Words'

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Summary

Besides being a highly prolific unconventional reservoir in Alberta-Canada, the geology of the Duvernay Formation is unique as it records relationships of a linked system of organic-rich basinal deposits and coeval carbonate platform margins. For this study, several continuous outcrop exposures of the Late Devonian Perdrix Formation (Duvernay equivalent) allowed us to document in detail the sedimentary facies, the stacking patterns, and the stratal geometries across of a basin-to-margin system.

Preliminary observations indicate that platform margins provided not only abundant carbonate detritus but also might have been responsible for the semi-restricted physiography during deposition of the organic mudstones in the Duvernay. From meter to mm-scale, the variety of physical and biogenic structures attest to a highly dynamic and heterogenous depositional system. Abundant debris flow beds, erosional surfaces, onlapping and interfingering relationships, and intense bioturbation occur within a background sedimentation of organic-rich mudstones. Stacked into cycles of 1-6 meters, clay- and organic-rich calcareous mudstones alternate with bioturbated limestones (Figure 1). These cycles are usually bounded by bioclastic sandy laminae at the base and strongly bioturbated cemented horizons (hardgrounds?) towards the top. Within a cycle the clay and organic-rich beds decreases upwards in thickness and frequency, whereas the content of coarser carbonate material increases in the form of debris flows or turbidites. Debris beds range from few centimeters up to meters thick, they are poorly sorted, scoured at the base, and contain numerous oncoids and mudstone-limestone clasts. A simplified meter-scale stacking pattern has been proposed for the Duvernay equivalent strata of this study, this is represented by shoaling upward cycles (Figure 1) interpreted as 4^{th}–5^{th} order parasequences. The base of the cycles generally reflects less oxygenated and quieter bottom conditions which favored a better preservation and less dilution of organic material within the mudstones. Upwards in the cycles, the increase in coarser carbonate supply and the more agitated-oxygenated bottoms might have caused dilution and destruction of organic material within the mudstones.

Further, comparisons between outcrops and subsurface well cores from the Duvernay East Shale Basin revealed that sedimentary processes, facies and stacking patterns are notably similar in both outcrop and subsurface datasets; and suggest that capturing facies variability in outcrops can be applied to building more realistic subsurface stratigraphic frameworks and to better understand reservoir distribution in the Duvernay play.

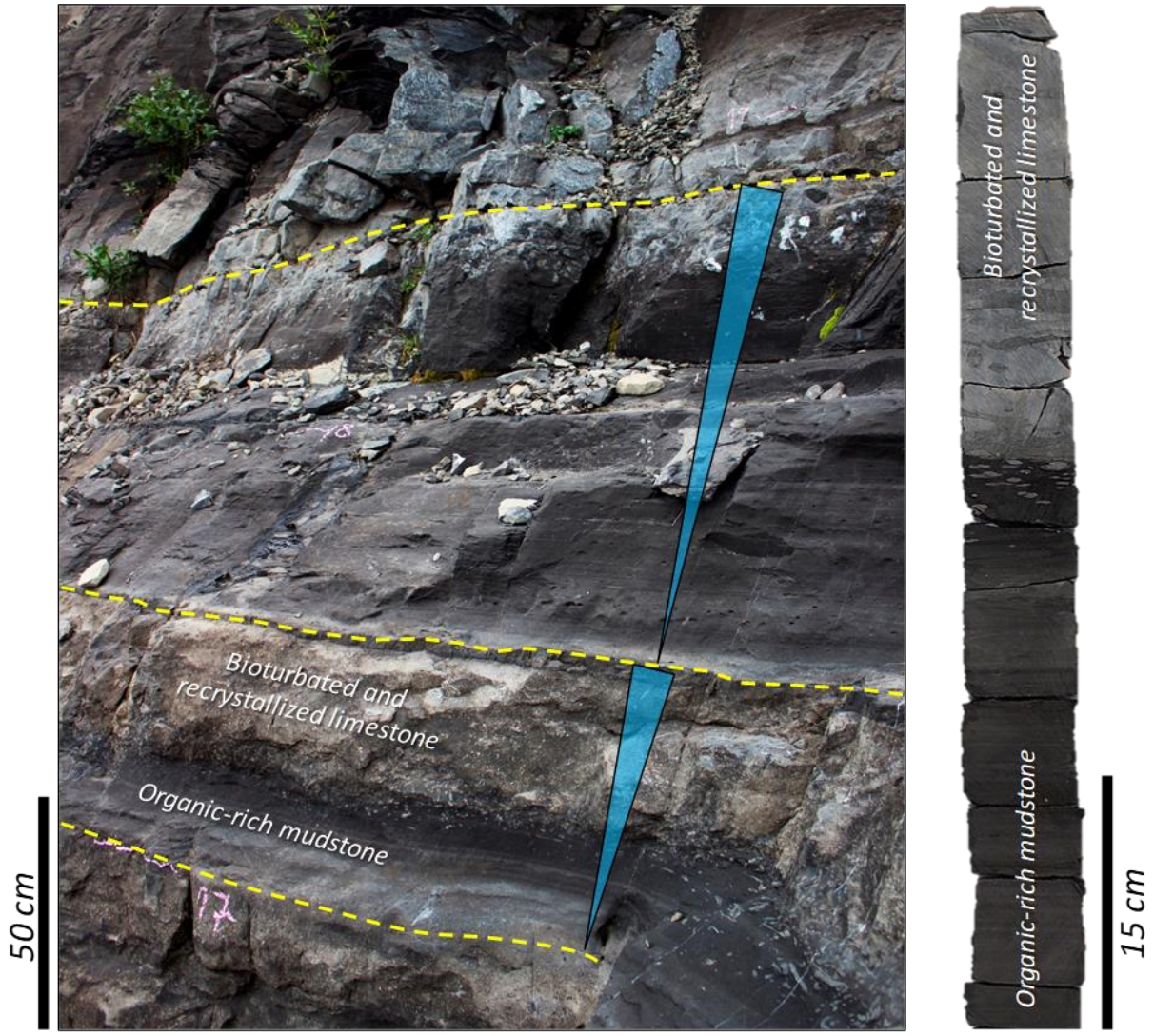

Figure 1. Left: Outcrop photograph of the Perdrix Formation illustrating the stacking of facies into shoaling upward cycles. Right: Core interval of the Duvernay Formation in the East Shale Basin showing a similar cycle of organic-rich mudstones and bioturbated limestones.

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