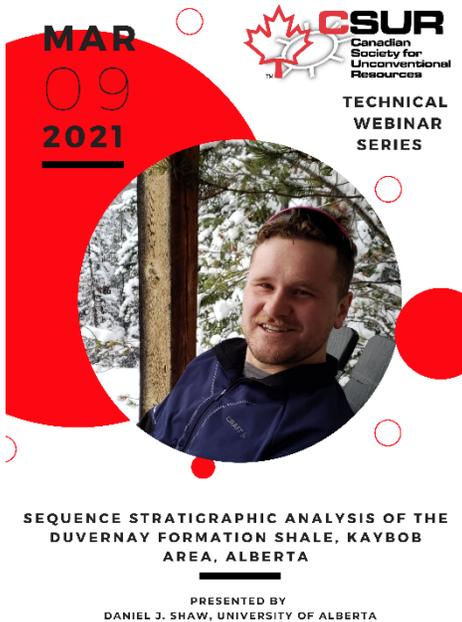


March 2021 – CSUR Technical Webinar #1

Sequence stratigraphic analysis of the Duvernay Formation shale, Kaybob area, Alberta



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SEQUENCE STRATIGRAPHIC ANALYSIS OF THE
DUVERNAY FORMATION SHALE, KAYBOB
AREA, ALBERTA

PRESENTED BY
DANIEL J. SHAW, UNIVERSITY OF ALBERTA

Daniel Shaw from the University of Alberta presented the findings from his master's program work on the Sequence Stratigraphic Analysis of the Duvernay Formation Shale in the Kaybob Area, Alberta. While the Montney play grabs the bulk of the attention typically, the Upper Devonian Duvernay Formation mudstone is also considered an important hydrocarbon source rock in the Western Canadian Sedimentary Basin (WCSB). In addition, the Duvernay has played a significant role within the Unconventional Resources sector in Alberta since the early 2010's. Although Daniel's talk was focused on the Kaybob portion of the play, it is noted that the play has gained significant traction elsewhere in the province, including with the increased activity in the East Shale Basin area in recent years.

To set the stage for the talk, the speaker referred to previous studies on the Duvernay that have focused on the transgressive / regressive cycles, while other past studies have looked at the sequence boundaries to define a more complete depositional history. The motivation for this work was based on identifying a more thorough understanding of the depositional environment, taking into account the spatial and stratigraphic variations of the surfaces.

With the overall scope and objectives in place, Daniel elaborated on his detailed process and analysis to characterize the lithofacies, identify the depositional sequences & systems tracts, and describe the mudstone sequence boundaries. The study area within the Kaybob region involved logging cores from 11 wells and correlating about 600 wells into the analysis.

Based on discussions with the speaker during the Q/A session, it is possible that the process and workflow developed for this study could be extended to the remainder of the Duvernay play in the WCSB. In addition, the findings from this study could be incorporated with other parallel studies to further characterize the Duvernay Formation and the performance of the wells.

Summary

The Upper Devonian Duvernay Formation mudstone is an important hydrocarbon source rock in the Western Canada Sedimentary Basin and has been a significant unconventional reservoir since 2011. Understanding heterogeneity within self-sourced reservoirs is important in predicting rock properties (such as TOC, porosity, permeability, and brittleness), which may be used to identify target intervals. These properties change with systems tracts and position within a basin at several scales and may be predicted by sequence stratigraphic models. Our analysis of 11 long cores in the Kaybob area identifies five lithofacies deposited by a combination of suspension settling, sediment-gravity flows, and bottom

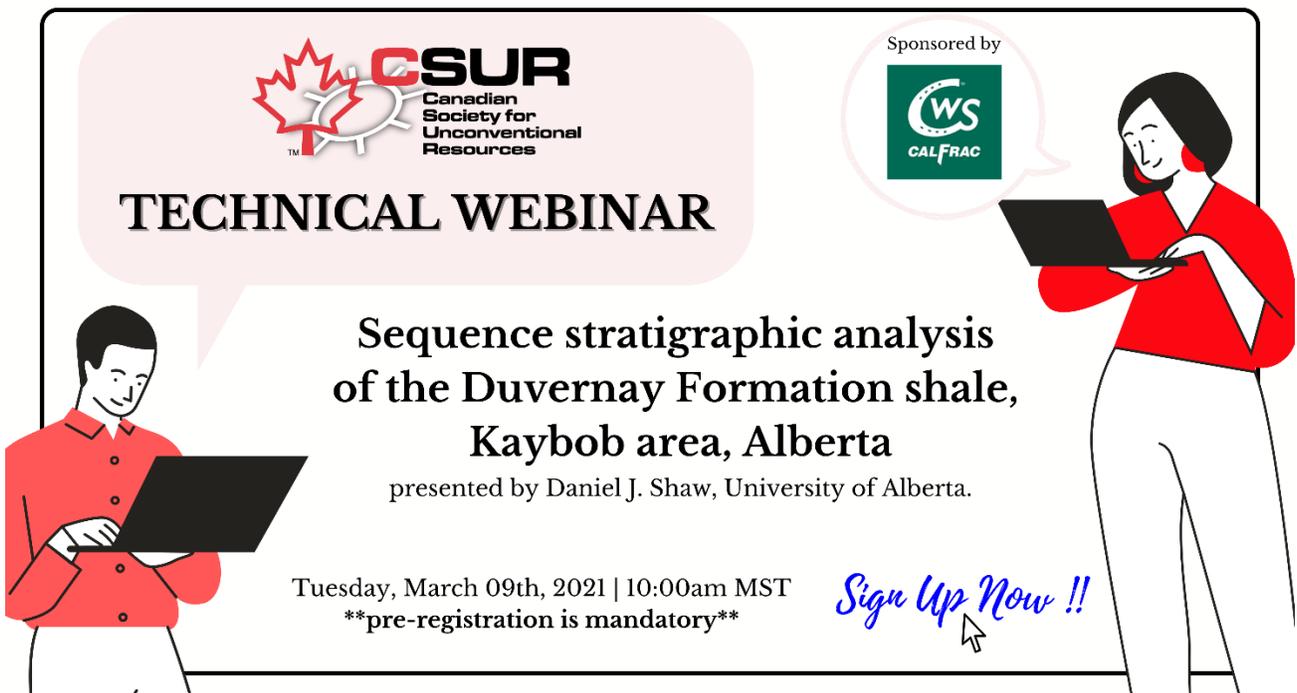
currents under anoxic to fully oxygenated bottom water conditions. Three 3rd order depositional sequences (DS1-3) are identified within the Duvernay Formation, bounded by 4 sequence boundaries (SB0-3). Sequences are defined by vertical facies patterns in cores and by stratigraphic stacking patterns on wireline logs.

The bases of DS1 and DS2 are major flooding surfaces that mark the beginning of transgressive systems tracts (TST) and are characterized by increasingly fine-grained, organic-rich, biosiliceous facies. The TSTs are overlain by highstand systems tracts (HST), represented by increasingly coarse-grained, carbonate-rich, bioturbated, organic-poor facies. The base of DS3 is marked by a rapid transition to detrital clay-rich, bioturbated facies, interpreted to be a lowstand systems tract (LST), which is overlain by a TST and HST. These three 3rd order cycles are superimposed on a 2nd order late TST and early HST, in which the 2nd order MFS coincides with the MFS in DS2. Fourth order depositional sequences (2-8 m scale) are also identified in the Duvernay, based on trends within depositional packages that include increasing calcite content, decreasing TOC, increasing abundance and size of burrows, and increasing grain size.

Two types of 3rd order sequence boundaries are identified, their expression dependent on whether they occur within the 2nd order transgression or highstand. In the 2nd order transgression, sequence boundaries are expressed as scoured surfaces with coarse overlying lags that represent a period of sediment starvation and reworking during lowstand conditions and early transgression. In the 2nd order highstand, sequence boundaries are expressed as soft sediment-deformed surfaces overlain by coarse beds that represent a period of forced regression, with the sequence boundary located at the top. Surfaces become gradational and overlying lags or forced regressive deposits thin basinward.

PRESENTER: Daniel J. Shaw, University of Alberta.

Daniel completed his BSc. (Hons.) in Geology at the University of Manitoba in 2017 and his MSc. at the University of Alberta in 2020. Daniel has worked for the Manitoba Geological Survey, for Syncrude in the Canadian oil sands, and currently in gold exploration for Great Bear Resources.




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**Sequence stratigraphic analysis
of the Duvernay Formation shale,
Kaybob area, Alberta**
presented by Daniel J. Shaw, University of Alberta.

Tuesday, March 09th, 2021 | 10:00am MST
****pre-registration is mandatory****

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