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Preliminary Stratigraphic Framework for the Lower Mannville Dina-Cummings Interval, East Central Plains, Alberta

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Summary

The Dina and Cummings interval in the East Central Plains of Alberta consists of a spatially complex assemblage of siliciclastic strata deposited during transgression of the Boreal Sea in late Aptian-early Albian time. This complexity results from a number of factors which include, but are not limited to, paleotopography along the sub-Cretaceous unconformity and location within an area of low-accommodation in the Western Canada Sedimentary Basin.

Published studies of the Dina and Cummings within Alberta are relatively rare and within which there is often discrepancy between the formal lithostratigraphic rank (Member vs. Formation), placement of lithostratigraphic tops (Fig. 1A), and interpretation of depositional environments (e.g. Nauss 1945; Wickenden, 1948; Kent, 1959; Fulgem, 1970; Orr et al., 1977; Vigrass, 1977). Two issues from this lithostratigraphic approach can be highlighted. First, in both examples shown in Figure 1A, the Dina top is placed at the top of a clean sandstone interval. Correlations based on this placement may be possible (and desirable) at the reservoir scale, but over larger distances and away from the channel into off-channel locales this correlation is difficult to consistently establish. Second, as can be seen in core, placing the top of the Dina at this sand is geologically problematic for 2 reasons: (1) heterolithic IHS deposits genetically associated with the channel itself are grouped with heterolithic facies of the overlying Cummings Member; and, (2) core observations indicate that there is a significant sub-aerial unconformity separating the lower and upper portions of these heterolithic deposits (blue line in Figure 1).

This project was undertaken with the goal of identifying and defining regionally mappable stratigraphic units and their bounding surfaces to aid in correlation for both industry and regulatory use. Analysis indicate that 4 regionally mappable stratigraphic units comprise the presently named Dina and Cummings Members. These are, in descending order, informally named: Dina-Cummings A, B, C and D units. Each unit has a distinct set of sedimentological and ichnological characteristics and are bounded by surfaces that in core can be shown to have sequence-stratigraphic significance. These surfaces are also readily identified on petrophysical well logs. From a sequence stratigraphic perspective, the units record a number of high-frequency progradational cycles nested within a lower-frequency retrogradational package of strata.

Study Area and Dataset

The project area is located within the East-Central Plains region of Alberta between Townships 45-54, and ranges 1-8W4 Meridian (Fig. 1B). Forty-five core were examined to establish a facies association scheme and to recognize the presence of important lithological contacts. These surfaces were picked on corresponding petrophysical logs and correlated to surrounding wells. Stratigraphic tops were correlated in approximately 3500 wells for an average of 48 wells per section. However, only about 1500 wells intersected the top of the Dina-Cummings D unit.

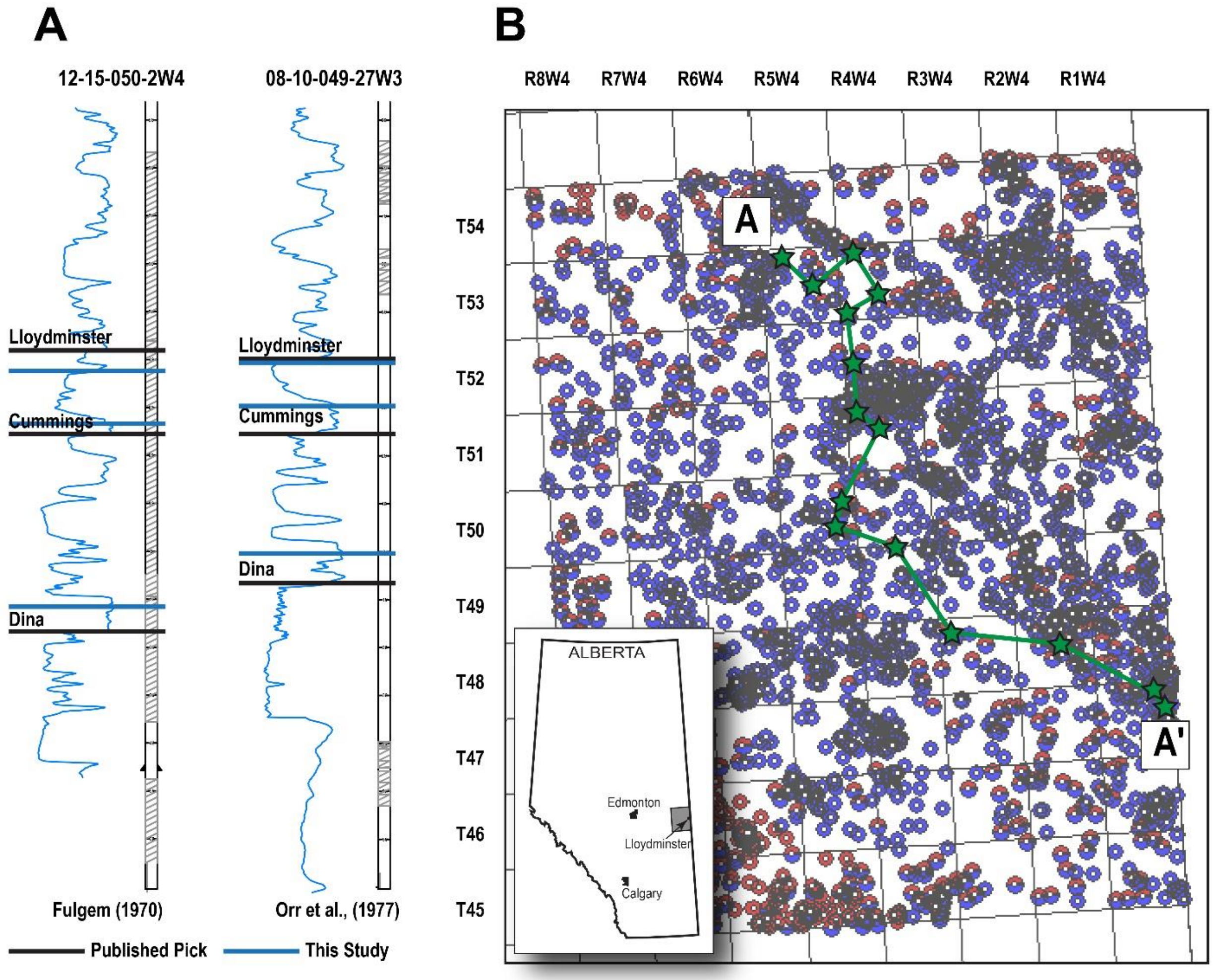

Figure 1: A) Example of lithostratigraphic top placement from Fulgem (1970), Orr et al., (1977), and proposed top placement for this study. B) Map showing the density of data, location within Alberta, and cross-section line shown in Figure 3.

Results

4 regionally-mappable, discrete stratigraphic units bounded by discontinuity surfaces were recognized in core and petrophysical log correlations. These are informally named the Dina-Cummings A, B, C, and D units. The general geological characteristics of these units and their bounding surfaces are summarized below and illustrated in Figure 2.

Dina-Cummings D: is the lower-most stratigraphic unit present and directly overlies the sub-Cretaceous unconformity. The D unit dominantly comprises stacked fining-upward and aggredational facies associations; coarsening-upward cycles do occur but are thinner and less laterally continuous than those within higher stratigraphic units. In core, these sequences are geologically consistent with a number of settings, including fluvial channel, overbank and floodplain facies, and tidal channel and sub- to supratidal flat facies. Gradations between end-members were observed, and increasing tidal influence upward is documented. Facies directly below the contact with the overlying C unit are commonly rooted, show evidence of pedogenic alteration (concretion growth, mottling, slickenside striations), and/or are bioturbated with trace fossils indicative of continental settings (i.e. *Scoyenia, Taenidium*).

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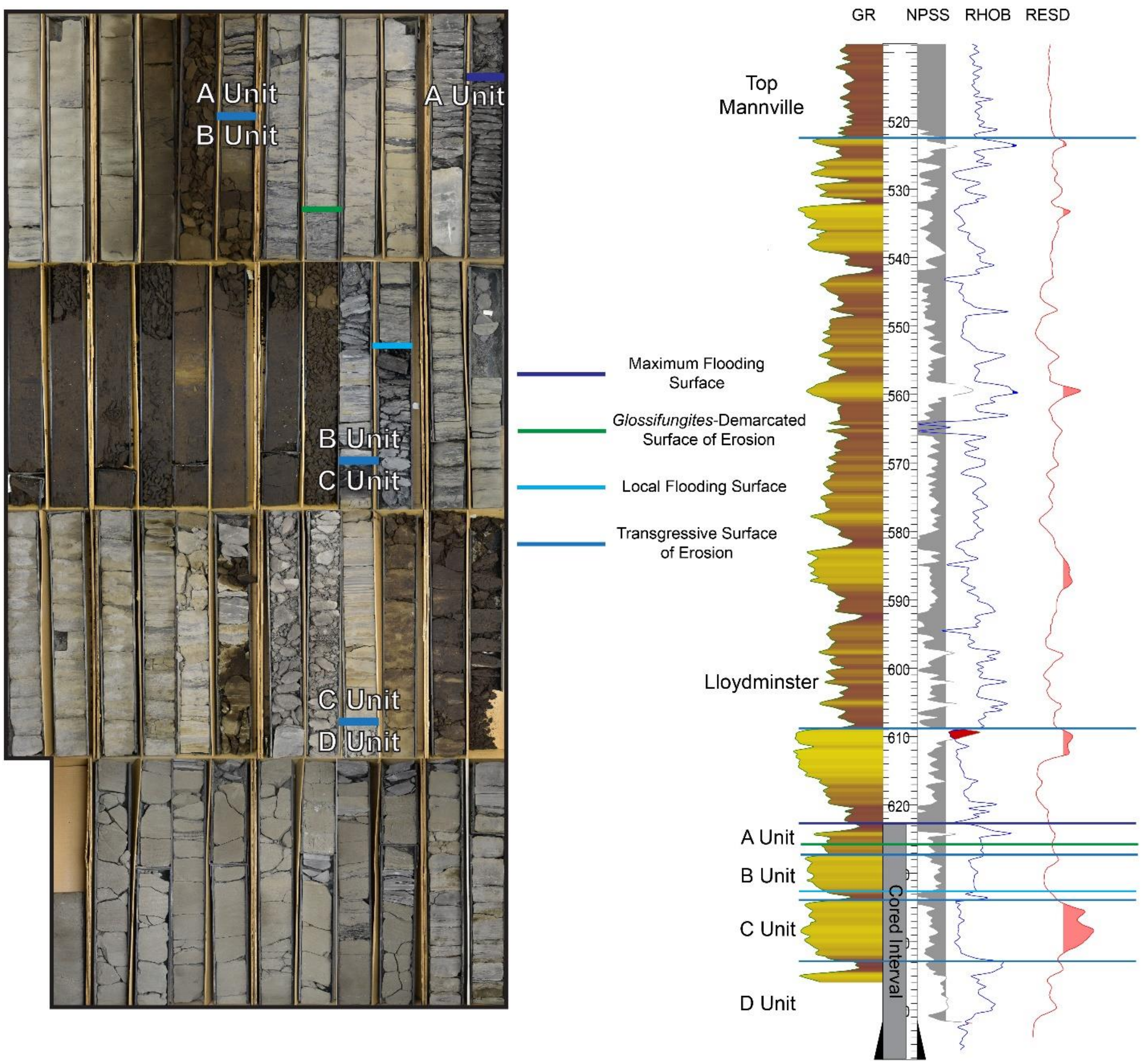

Figure 2: Core and corresponding petrophysical log showing the stratigraphic relationships of the Dina-Cummings Units A-D.

Dina-Cummings C: overlies the D unit and consists of one to three metre-scale cleaning-upward sequences. It consists of bioturbated silty mudstone grading into bioturbated to low-angle planar laminated sandstone. Trace fossil size, diversity and ethology are consistent with brackish-water conditions (e.g. diminutive forms, low- to mono-specific diversity, simple, facies-crossing forms)

The C unit is capped by a regionally mappable thin coal seam (Fig. 2). Facies relationships across the boundary of the C to D unit indicate a landward shift of the shoreline, emplacing sub-aqueous brackish-water facies directly above coastal plain to fluvial sediments. The Dina-Cummings B is preliminarily interpreted as prograding shorelines into a shallow, brackish-water bay.

Dina-Cummings B: consists of one to several metre-scale cleaning upward cycles. The B unit differs from the underlying C unit in a few key ways. First, the B Unit appears slightly glauconitic, while the C is not. Second, trace fossil diversity in the B unit is higher, with more robust forms. Third, while it may be due to pervasive oil staining in the C unit, the presence of tidal influence appears greater in the B unit, as double mud drapes are more prevalent. The Dina-Cummings B is tentatively interpreted as being deposited near the mouth of an estuary, in the zone of significant tidal modulation of sedimentary processes.

Dina-Cummings A: consists of one to several cleaning-upward cycles in which mud content increases with each successive cycle. These cycles are characteristically separated by flooding surfaces or *Glossifungites*-demarcated discontinuities. The A unit differs from the B unit in three primary ways. First, the A unit appears to have a higher glauconite content. Second, trace fossil diversity is higher, and trace fossils are slightly larger in Unit A. The most important difference is the presence of marine-associated forms including abundant, robust *Asterosoma* and *Scolicia*, with lesser *Zoophycos, Chondrites, Phycosiphon, Schaubcylindrichnus, and Helminthopsis.* The top of the A unit is interpreted to represent maximum transgression of the Boreal sea and as such is the Lower-Upper Mannville contact.

Preliminary Conclusions

Based upon core observations and petrophysical correlations, the Dina-Cummings interval can be sub-divided into 4 regionally mappable stratigraphic units (Fig. 3). These units are bounded above and below by discontinuity surfaces that are mappable at least across the project area and are readily identifiable on petrophysical wireline logs. The result is more geologically feasible and consistent correlation of units. Also documented in this study are the sedimentological and ichnological attributes of high-frequency progradational cycles nested within an overall retrogradational package of strata. Future work will aim to extend these surfaces to a larger area, incorporate geochemical data (XRF and XRD), and continue this work into overlying Upper Mannville Group sediments.

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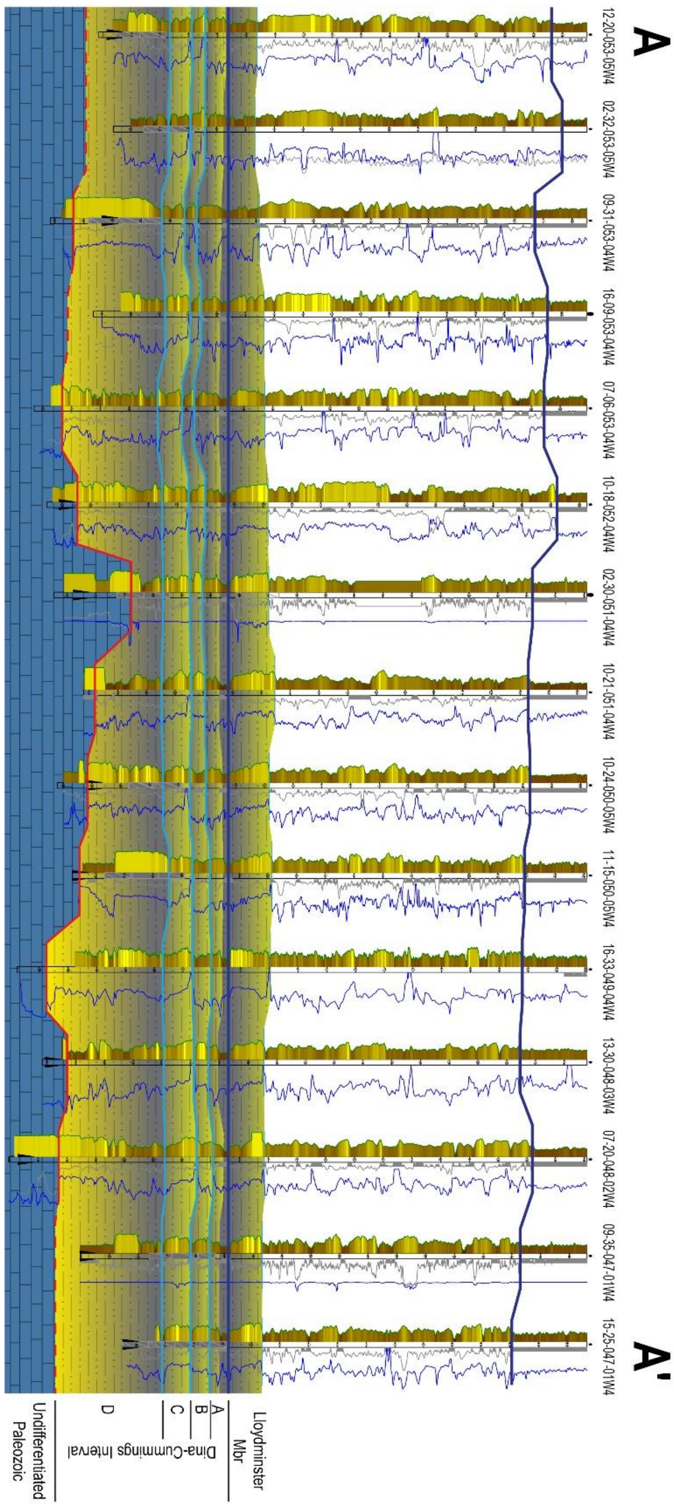

Figure 3: Stratigraphic cross-section with Dina-Cummings A, B, C, and D tops shown. Cross-section is hung on the top of the A Unit.