# REGIONAL ALLOSTRATIGRAPHIC CORRELATIONS ACROSS A FORELAND BASIN: EVIDENCE FOR A TECTONICALLY- OR EUSTATICALLY-DOMINATED SYSTEM?

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## Summary

The Cenomanian to Early Turonian Fish Scales to Second White Specks interval was deposited during a time of overall marine transgression and tectonic loading in the Western Cordillera. Basin-wide allostratigraphic correlations demonstrate a dynamic coupling between allomembers mapped in the foredeep and across the forebulge into the backbulge segments of the Western Canada Foreland Basin (WCFB). Allostratigraphic surfaces established in the foredeep and extended into the backbulge reveal the influence of a forebulge at time of deposition. Some of the mudstone-rich allomembers in the foredeep are coeval with stratal packages of carbonate-rich, clastic-starved sediment in the backbulge; some allomembers, however, are restricted to one segment of the basin. Overall, a high-degree of stratigraphic condensation occurs along the putative forebulge trend (in the vicinity of the 4th Meridian), with slight thickening eastward into eastern Saskatchewan, reflecting the influence of vertical motion of the forebulge on local accommodation.

## Introduction

Recent studies suggest that organic matter preservation in mudstones is, at least in part, dependant on the formation of organomineralic aggregate particles (MacQuaker et al., 2010) and the sedimentary processes responsible for their transport and deposition (Plint et al., 2012; Plint, 2013). The temporal and spatial organic matter in self-sourcing carbonaceous mudstone reservoirs is, therefore, revealed by mapping coeval stratal packages. High-frequency allostratigraphic correlations provide a practical method for identifying temporal relationships within an approximately chronostratigraphic framework. Relating depositional processes that encourage organic matter preservation to stratal packaging in a basin evolution context provides the basis for predicting stratigraphic and geographic limits of discrete carbonaceous mudstone petroleum systems.

Our study focuses on the Second White Specks (equivalent to the Vimy Member, Blackstone Formation in the foothills) to Fish Scales interval of the Upper Cretaceous Colorado Group, in the WCFB. The broad spectrum of depositional and burial histories of the Colorado Group mudstone succession provides an excellent opportunity for understanding the diverse relationships between sedimentary facies, depositional fabric, basin evolution, and petroleum system development. In this study, we present results from a high-frequency allostratigraphic framework developed for the Second White Specks to base of Fish Scales interval, spanning

the foredeep (Alberta foothills), forebulge (Alberta-Saskatchewan border), and backbulge (central to eastern Saskatchewan) segments of the WCFB.

## Theory and/or Method

Tyagi et al (2007) demonstrated that temporal gaps in the Colorado Group stratigraphic record can be identified by mapping regionally-correlative bounding disconformities. Our work uses this approach to reconcile the established allostratigraphic framework in the foredeep (e.g.: Tyagi et al., 2007) with the lithostratigraphic-based framework in the backbulge segment of the WCFB (e.g.: Christopher et al., 2006). A grid of cross sections spanning the foredeep to backbulge regions of the basin has been constructed using digital well log data and designed to intersect described cores in the interval of interest. Logged core data provides visual evidence to ground-truth significant allostratigraphic surfaces in regional well log correlations. The cross sections tie into published allostratigraphic cross sections (e.g.: Tyagi et al., 2007) to maintain consistency when extending the framework eastward into the backbulge.

## Examples

Regional correlations provide insight into the dynamic relationship between foredeep, forebulge, and backbulge stratal sequences. Major bounding surfaces identified in core were extended from the foredeep to the backbulge. Correlations indicate some allomembers are coeval across the forebulge and some are not. Correlative stratigraphic and geophysical log markers provide visual evidence of stratal condensation in the vicinity of the Third Meridian. Downlapping and truncation of log markers immediately west of the Third Meridian and a distinct thickening of strata to the east implies the forebulge was active at time of deposition. Lithological evidence indicates a high degree of condensation and localized erosion has occurred within the Second White Specks to base of Fish Scales interval between the forebulge and backbulge regions. In general, the stratal packages are mudstone-rich with sporadic interbedded silty-mudstone to very fine sandstone intervals in the foredeep; the distal edge of the forebulge to backbulge, however, preserves a distinctly different assemblage of lithologies dominated by calcareous mudstones with interbeds of foraminiferal- and bioclastic-rich limestone. The foraminiferal limestone horizons are significant stratigraphic markers signifying episodes when the backbulge depositional system was effectively starved of clastic sediment supply. Correlations suggest these episodes correspond with times of active loading in the foredeep, which trapped clastic sediment in the west due to flexural uplift of the forebulge (Varban and Plint, 2005). The sharp flooding contacts between carbonate material and calcareous mudstone are evidence of reactivated sediment supply and increased accommodation.

## Conclusions

The Second White Specks to base of Fish Scales is a regionally extensive stratal succession that spans the WCFB. A basin-wide allostratigraphic framework establishes an approximate chronostratigraphic relationship between the mud-dominated sediments in the foredeep with the carbonate-rich, clastic-poor sediments in the backbulge. Correlations show a high degree of stratigraphic condensation along the Alberta-Saskatchewan border and slight thickening towards central Saskatchewan. The thick successions in the foredeep are coupled with backbulge sediments through mapping of surfaces identified by anomalous lithofacies juxtaposition. A previous result from this research work demonstrates that discontinuity-

bounded rock units have distinct pyrolysis characteristics. Our high-frequency allostratigraphic framework provides the foundation for our next investigation which looks at the stratigraphic influence on pyrolysis characteristics across the basin.

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