

Paleogeographic and tectonic evolution of an Albian-Cenomanian foredeep succession, northeastern British Columbia

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Introduction

In the foredeep of NE British Columbia, Upper Albian to Lower Cenomanian strata, comprising the lithostratigraphic Hasler, Goodrich and Cruiser formations (Wickenden and Shaw, 1943; Stott, 1968), show lateral and vertical facies variability, indicative of a complex and rapidly-changing paleogeography. Broadly, sandstone-rich nearshore facies in the far west grade laterally eastward into siltstone, and ultimately claystone facies over several hundred km. The silt- and clay-rich facies comprise the lithostratigraphic Shaftesbury and Westgate formations of the Alberta Plains. The interfingering of tongues of nearshore sandstone with offshore mudstone indicate progradation of deltaic lobes under the influence of repeated relative sea-level changes, at least some of which can, on geometric grounds, be attributed to eustatic change. A new allostratigraphic scheme has allowed the rocks of the BC foredeep to be correlated and subdivided in terms of the allostratigraphic scheme developed by Roca et al. (2008) in Alberta.

Method and result

An allostratigraphic scheme, based on the correlation of marine flooding surfaces, has been employed to subdivide the up to ~700 m thick Albian-Cenomanian succession into about 18 genetic packages (allomembers). The bounding flooding surfaces closely approximate time lines and hence permit interpretation in chronostratigraphic terms. Typically, allomembers thin and become muddier basinward (eastward), either merging or pinching out against adjacent allomembers. The abundance of wave-formed structures (hummocky and swaley cross-stratification, wave and combined flow ripples, graded beds), indicate a strongly storm-dominated shelf. It is notable that there is no evidence for the development of one or more distinct downlap surfaces, and there is no evidence that the shelf had a sigmoidal geometry with a recognizable rollover to a 'prodelta' slope. It is therefore concluded that the shelf had a planar, wave-graded ramp morphology.

Within each allomember, facies units, determined on the basis of gamma ray log character as well as core and outcrop control, allowed paleogeographic maps and broad shoreline trends to be mapped. Because the sea floor had negligible relief, isopach maps of successive allomembers can be interpreted as a record of contemporaneous tectonic subsidence. The isopach maps show that the pattern of subsidence changed (sudden increase in subsidence rate above the WE2 marker). Nearshore sandstone packages have a progradational stacking pattern up to surface FE1 that marks the Albian-Cenomanian boundary; overlying sandstones have a retrogradational pattern. The most regressive shoreface sandstone corresponds closely to the Albian-Cenomanian boundary and may be the local expression of eustatic fall that is expressed in more distal parts of the basin as an erosion surface and intraclastic lag that marks the 'Base Fish' log marker.

In areas located more than ~80-90 km from shore, distinctive 'hot' mudstones developed, particularly at times of major marine transgression. At such times, it is inferred that the supply of clastic

detritus to the shelf was minimal. Organic matter (both terrestrial and pelagic), was incorporated into shelf mudstone as a result of high instantaneous sedimentation rate (i.e. post-storm settling of mud aggregates) that led to preservation of organic matter by anoxic pore water a few mm below the sea floor. It is also possible that the most prominent 'hot mudstone' above the 'Base Fish Scales Marker' (of Roca et al. 2008) owes its particularly high organic content, and attendant radioactivity, to deposition beneath a density-stratified water column, as suggested by Schröder-Adams et al. (1996), and attributed to the initial mixing of the Boreal and Tethyan water-masses.

Conclusions

The studied succession offers a particularly well-preserved and highly expanded record of Late Albian and early Cenomanian sedimentation, including an excellent record of oceanographic and eustatic events across the Stage boundary. Abundant well log data allow detailed allostratigraphic mapping of genetic depositional units, for which successive paleogeographic maps can be reconstructed. Successive isopach maps reveal spatial changes in the pattern of flexural depocentres that in turn must echo evolving patterns of deformation in the Cordilleran Orogen. The stacking pattern of regressive-transgressive successions reveals the interplay of eustatic fluctuations with an overall high, but variable rate of tectonic subsidence.

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