

# **Clinof orm Architecture of a Shale Dominated Succession in the Cretaceous Colorado Group, Central Alberta**

Dallin P. Laycock  
Department of Geoscience  
University of Calgary, Calgary, Alberta  
dplaycoc@ucalgary.ca

Per K. Pedersen  
Department of Geoscience  
University of Calgary, Calgary, Alberta

Steve Larter  
Department of Geoscience  
University of Calgary, Calgary, Alberta

Haiping Huang  
Department of Geoscience  
University of Calgary, Calgary, Alberta

Ron Spencer  
Department of Geoscience  
University of Calgary, Calgary, Alberta

Andy Aplin  
School of Civil Engineering and Geosciences  
University of Newcastle upon Tyne, Newcastle, UK

## **Abstract**

Recent publications from both ancient and modern environments have shown that mud-dominated successions can contain complex internal geometries featuring numerous clinoforms, which if present will exert a strong control on shale gas exploration targets. These mud-dominated clinoforms span over 50 km in length and are tens of meters in height. The subtleties of their shallow gradients make them difficult to recognize in cross sections. Despite the difficulty of recognizing them, they are sedimentary bodies with facies that vary in three dimensions, which is an important consideration in mapping shale gas fairways. And thus, their distribution and sedimentary characteristics must be understood. This study contains an investigation in mapping these sedimentary bodies and their associated facies in the subsurface.

The Wildmere area of central Alberta contains clinoforms within the Upper Colorado Group shale. They are correlated using cross sections from induction logs with close well spacing. These cross sections are correlated according to the principles of seismic sequence stratigraphy. Correlating in this method defines large clinoforms spanning over 80 km in length. The clinoforms are separated into different units that resemble "systems tracts". The production trends from the Wildmere area show that the production is concentrated in certain systems tracts, suggesting that they play an important role in the production from these units.

In core, the systems tracts are characterized by an upward increase in sand content with the top of the systems tracts demarcated by glauconite rich horizons, shell hashes, pebble lags, or scoured surfaces, likely reflecting erosion or non-deposition. Geochemical data show significant changes across the system tract boundaries, thus supporting the interpretation of the system tracts as distinct sedimentary units. Biostratigraphy data also show changes of the fossil assemblages across these boundaries, and suggest that there were hiatuses in deposition and changes in the paleoenvironment. These surfaces are laterally extensive, and can be used to map the distribution of the clinoforms. Thus, the systems tracts can be mapped in 3-dimensions, which can help identify and map shale gas fairways.

Depositional models of the facies distribution along these clinoforms is key for exploration and production strategies involving such units. Understanding the depositional processes and environment of muddy clinoforms is important in resolving the trends of the facies distribution. The winnowed and eroded surfaces separating the clinoforms are consistent with observations from modern analogues. In these modern analogues, winnowed and eroded surfaces are the product of alongshore subaqueous currents. These currents also appear to influence the gradient of the clinoforms, which could provide insight into the development of muddy clinoforms in certain settings. The preliminary 3D mapping of mudstone clinoforms in the Wildmere area provides support for this interpretation, which is valuable information in the delineation of facies belts.