

SEQUENCE STRATIGRAPHIC ARCHITECTURE OF THE FRASNIAN CLINE CHANNEL, CENTRAL ALBERTA FRONT RANGES

Pak Wong (Retired), John Weissenberger (Alberta Energy Regulator) and Murray Gilhooly (Retired).

Abstract

Carbonate strata were widely deposited in the Alberta Basin during the Devonian. Ten third-order composite sequences and their constituent high-frequency (fourth-order) sequences span the uppermost Givetian through Frasnian strata of the Alberta Basin. They reflect stratigraphic architecture typical of a (second-order) depositional sequence: transgression followed by regression, or basin opening and filling. The Frasnian (Upper Devonian) sequences are well exposed in the Alberta Rocky Mountains and regionally extensive in the adjacent subsurface.

The margins of the Frasnian Cline Channel are preserved in excellent and continuous exposures at both Cripple Creek and Wapiabi Gap in the Alberta Rocky Mountains. Accretionary interfingering platform margins allow detailed definition and correlation, from platform to basin, of significant sequence stratigraphic surfaces.

Eight Frasnian third-order composite sequences are defined using stratal and lithofacies stacking patterns, regional correlation of sequence boundaries, and maximum flooding surfaces, constrained by conodont biostratigraphy. They form part of an upper Givetian–Frasnian second-order transgressive–regressive depositional sequence. Most sequence boundaries observed show subaerial exposure. Others are inferred from facies offset, such as the onlap of tidal-flat or reef margin deposits onto foreslope lithofacies.

The Cline Channel was filled asymmetrically by northeast progradation of the platform margin on a substrate of platform-derived fine-grained carbonates and extrabasinal clays that form argillaceous carbonates and calcareous shales. Stacking patterns of the composite sequences vary across the channel. On the southeast side, the second-order Givetian–Frasnian cycle is characterized by initial retrogradation followed by aggradation to retrogradation in the upper mid-Frasnian, and finally, progradation in the upper Frasnian. On the northwest side, the overall stacking pattern is aggradational.

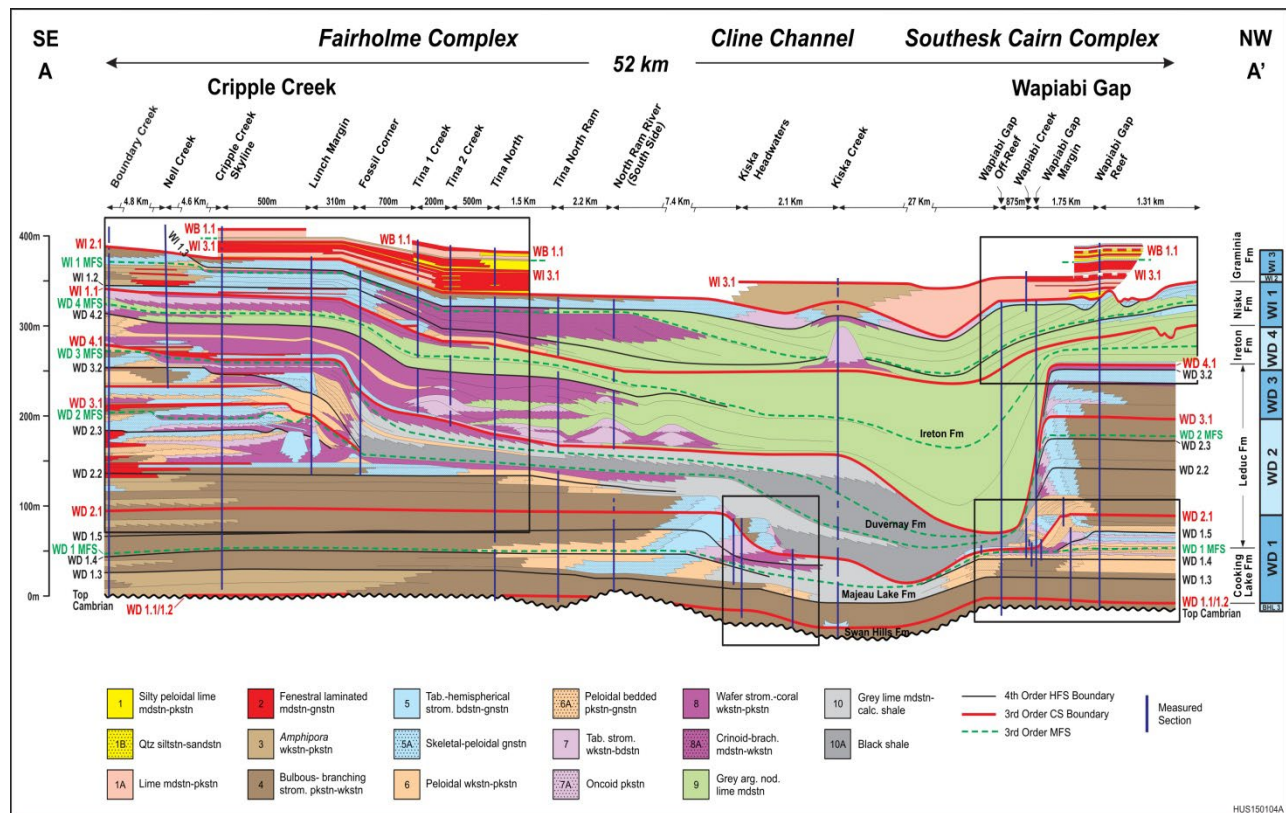
With progressive basin filling, foreslope declivity decreased from greater than 10° (WD3) to less than 1.5° (WI1) during the evolution of the second order highstand. Coincident with this change, lowstand geometry changed from wedge shaped to tabular. Where slope gradients were high, lowstands are wedge-shaped, less extensive and abutt antecedent highstands. With the evolution to more ramp-like geometries, lowstands became tabular-shaped. Gentle slope gradients and larger areas for shallow-water carbonate production facilitated extensive lowstand development. Assignment of strata into systems tracts of ramp-like systems is facilitated by subregional correlation.

Decreasing accommodation within the second-order highstand is indicated by reduction in composite sequences (CSs) thickness and replacement of open marine with platform-interior strata as the basin shallowed and filled. Composite sequences became more asymmetric,

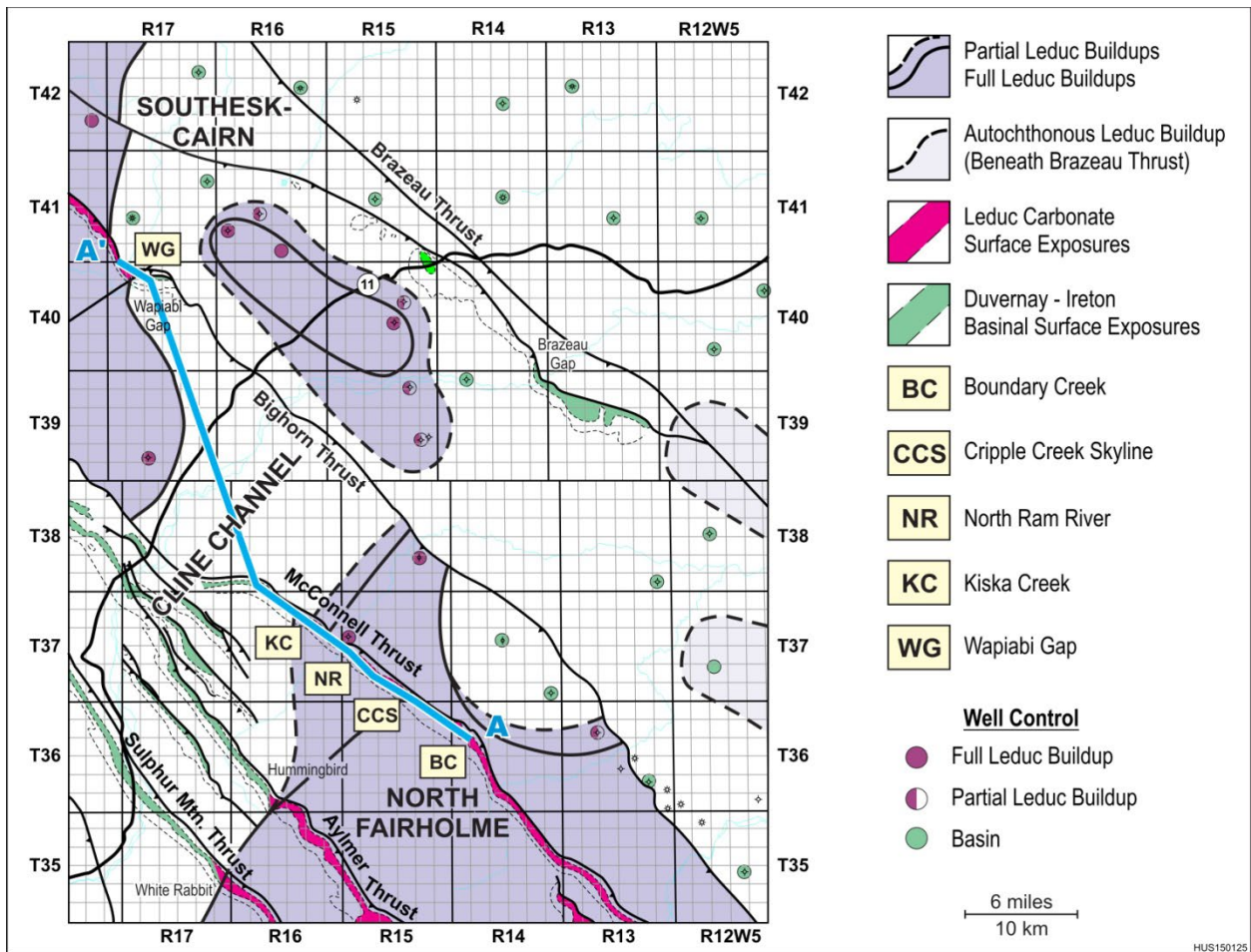
developing thin, offlapping falling stage systems tracts in the late Frasnian, accompanied by a higher frequency of lowstands. Continuous outcrop exposures permitted the amount of relative sea-level fall to be estimated for the bounding surfaces of several CSs from 9 to ~40 m.

References

Wong PK, Weissenberger JAW, Gilhooly MG. 2016. Sequence stratigraphic architecture of the Frasnian Cline Channel, Central Alberta Front Ranges. In Playton TE, Kerans C, Weissenberger J (Editors). *New Advances in Devonian Carbonates: Outcrop Analogs, Reservoirs, and Chronostratigraphy*, Special Publication 107: SEPM (Society for Sedimentary Geology), Tulsa, Oklahoma. DOI: 10.2110/sepmsp.107.08



Southeast to northwest cross section of the Cline Channel, from Cripple Creek to Wapiabi Gap. Owing to scale constraints, the platform-interior strata are colored according to their dominant lithofacies type. Boxes demarcate areas of continuous exposure and detailed study, where measured sections were supplemented by photomontages and field mapping (from Wong et al, 2016).



Map of the study area showing line of cross-section A'–A in blue. The Cline Channel separates the Southesk Cairn, and the Fairholme complexes. This paleogeographic map is not palinspastically restored. Wapiabi Gap is located on the Big Horn thrust, whereas Cripple and Kiska creeks are on the McConnell thrust. (from Wong et al, 2016).