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Sedimentary processes and organic matter dynamics of Late Cretaceous fluvial floodplains, Dinosaur Provincial Park, Alberta

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Theory / Method / Workflow

Despite being dynamic surficial sources and sinks of organic matter, floodplains remain underutilized for refining fluvial sedimentological and stratigraphic interpretations, particularly in energy-resource contexts. Unlike sandstone-rich channel deposits, floodplain successions are difficult to interpret because of the scarcity of diagnostic physical sedimentary structures and the high degree of late pedogenic overprinting, which may obscure depositional signals and limit their stratigraphic utility.

The Upper Campanian Dinosaur Park Formation (DPF) in Dinosaur Provincial Park (DPP), Alberta, provides an ideal setting to explore floodplain sedimentary organic matter dynamics and their paleoenvironmental and stratigraphic implications. This study uses exposures from DPP to contribute to answering the overarching research question: Can fossil sedimentary organic matter from fluvial rocks reveal detailed paleoenvironments and help refine our terrestrial stratigraphic record? This question is divided into two sub-research questions with hypotheses and objectives in the DPF context. The first sub-research question was: Can palynofacies discriminate floodplain sub-environments? The hypothesis is that low-thermal maturity floodplain sediments preserve kerogen assemblages reflecting floodplain depositional processes. Objectives included characterizing kerogen distributions within a DPF floodplain sequence, developing a lithofacies-coupled palynofacies model, resolving ambiguities in fluvial palynofacies interpretations, and refining paleoenvironments in the DPF. The second sub-research question was: Can $\delta^{13}C$ from floodplain organic matter serve as a chemostratigraphic tool for correlating Upper Campanian terrestrial deposits globally? The hypothesis is that organic matter in floodplain deposits records global carbon cycling processes. Objectives included obtaining a $\delta^{13}C_{TOC}$ record from a DPF floodplain sequence and comparing it with global $\delta^{13}C$ curves.

Results, Observations, Conclusions

Results from the first objective indicated that the studied DPP section preserved different organic matter assemblages with varying abundance (Fig 1). This understanding, together with sedimentary indices, helped identify floodplain sub-environments, such as levees, swamps, and proximal-distal floodplains, contributing to establishing a lithofacies-palynofacies model for meandering fluvial environments (Fig. 1). Our model is highly compatible with similar observations from modern and other paleo-fluvial systems, highlighting organic matter's potential to reveal fluvial paleoenvironments while confirming the first hypothesis. Results from the second objective indicated that the $\delta^{13}C_{TOC}$ record from the lower DPF aligned with global $\delta^{13}C$ trends, capturing the negative $\delta^{13}C$ excursion of the so-called Late Campanian Event. This confirms the second hypothesis and highlights floodplain deposits as valuable archives of global carbon cycle processes and stratigraphic markers (Fig.2).

Overall, this study demonstrates that organic matter preserved in floodplain deposits can be used to refine interpretations of fluvial environments through integrated palynofacies analysis and stable carbon isotopic studies.

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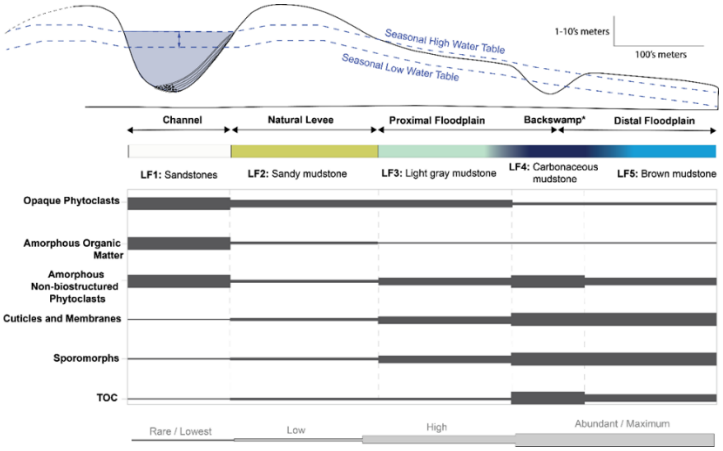


Figure 1: Lithofacies-coupled palynofacies conceptual model illustrating the variation in lithofacies, key palynofacies groups, and TOC across different sub-depositional environments within a Late Cretaceous meandering fluvial system (Goonetilleke et al., 2025).

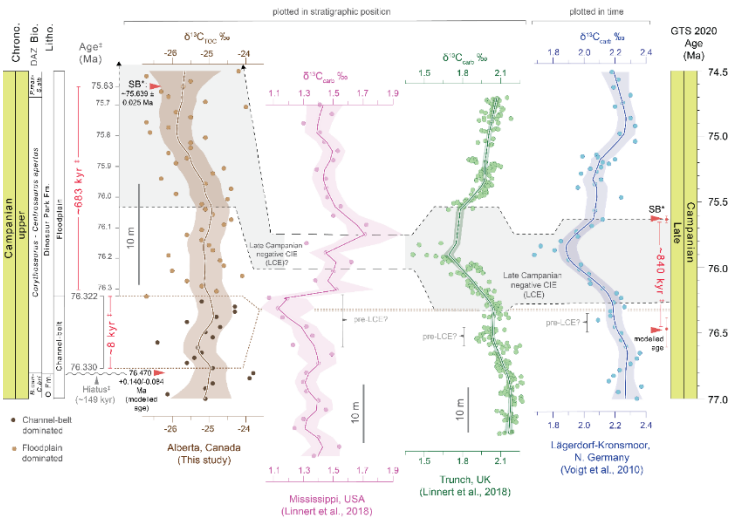


Figure 2: $\delta^{13}C_{TOC}$ record from the Dinosaur Park Formation correlated with $\delta^{13}C_{carb}$ records from North America and Europe, identifying a shared Late Campanian Event (LCE). LOESS-smoothed curves and age calibration to the Geological Time Scale 2020 demonstrate that this negative carbon isotope excursion is synchronous across terrestrial and marine sections, supporting a global carbon-cycle signal recorded in floodplain organic matter (Goonetilleke et al., 2026).

References

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