# Sedimentology and Ichnology of the Lower Cretaceous Wilrich Member (Lower Falher) of the Spirit River Formation.

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Despite the current climate of low gas prices, West-Central Alberta Deep Basin reservoirs are highly prospective. Production values from the Wilrich Member are typically in the range of 2-25 mmcf/day of gas with 5-70 bbl/mmcf of condensate plus liquids reported. Currently the understanding of reservoir facies and distribution of the Wilrich Member are not clearly understood. This project aims to rectify this situation by integrating detailed ichnology and sedimetology to result in high resolution facies analysis. This analysis is to be carried out on numerous cores. To date the integrated study has yielded several facies associations. Lower offshore mudstones and upper offshore sandy mudstones are pervasively bioturbated with the bioturbation index levels generally between 5 and 6. Trace fossil assemblages represent distal to diverse respectively expressions of the *Cruziana* Ichnofacies. Primary sedimentary structures are virtually absent but remnant sand beds occur locally and reflect the deposition of distal tempestites.

Deltaic deposits have strikingly different ichnological and sedimentological features from offshore/shoreface strandplain deposits. Several different types of deltaic deposits have been identified that reflect varying degrees of river, wave and storm influence.

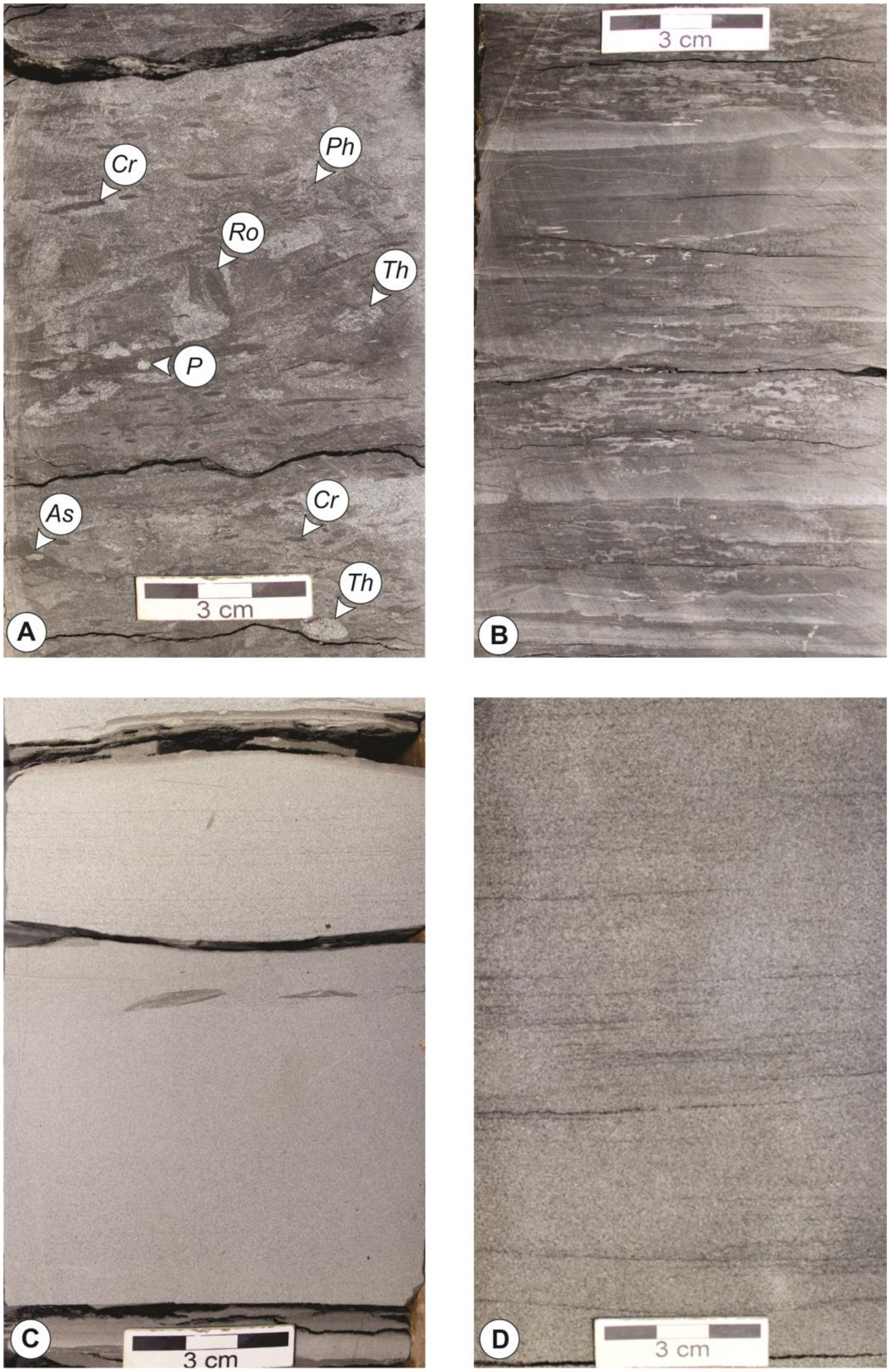
River-dominated prodeltaic deposits are heterolithic very-fine- to fine-grained sandstones, mudstones and claystones that are dominated by physical sedimentary structures such as sharp-based normally-graded sandstone to mudstone beds, carbonaceous claystone drapes, soft-sediment-deformation structures and abundant phytodetrius. Bioturbation is absent to sporadically distributed, with bioturbation index levels ranging from 0-2. The trace fossil assemblages consist of low-diversity suites that contain traces that are reduced in size as compared to fully marine counterparts. These assemblages represent persistently stressed marine suites that indicate frequent fluctuations in environmental conditions, heightened rates of deposition and persistent input of fresh water.

Mixed influence prodeltaic deposits are also heterolithic very-fine- to fine-grained sandstones, mudstones and claystones dominated by physical sedimentary structures such as sharp-based, normally graded sandstone to mudstone beds, sharp-based sandstones with storm-generated structures such as wavey parallel laminations, small-scale hummocky-cross-stratification and small-scale oscillation ripples with carbonaceous claystone drapes. Synaeresis cracks that reflect salinity fluctuations are present locally. Phytodetritus is common to abundant. Bioturbation is sporadically distributed with the BI ranging from 0-4. The trace fossil assemblages are moderately diverse and are dominated by fully marine grazing structures such as *Cosmorhaphe* and *Phycosiphon.* Other deposit-feeding structures are common and the assemblages represent stressed expressions of the *Zoophycos* and *Cruziana* Ichnofacies.

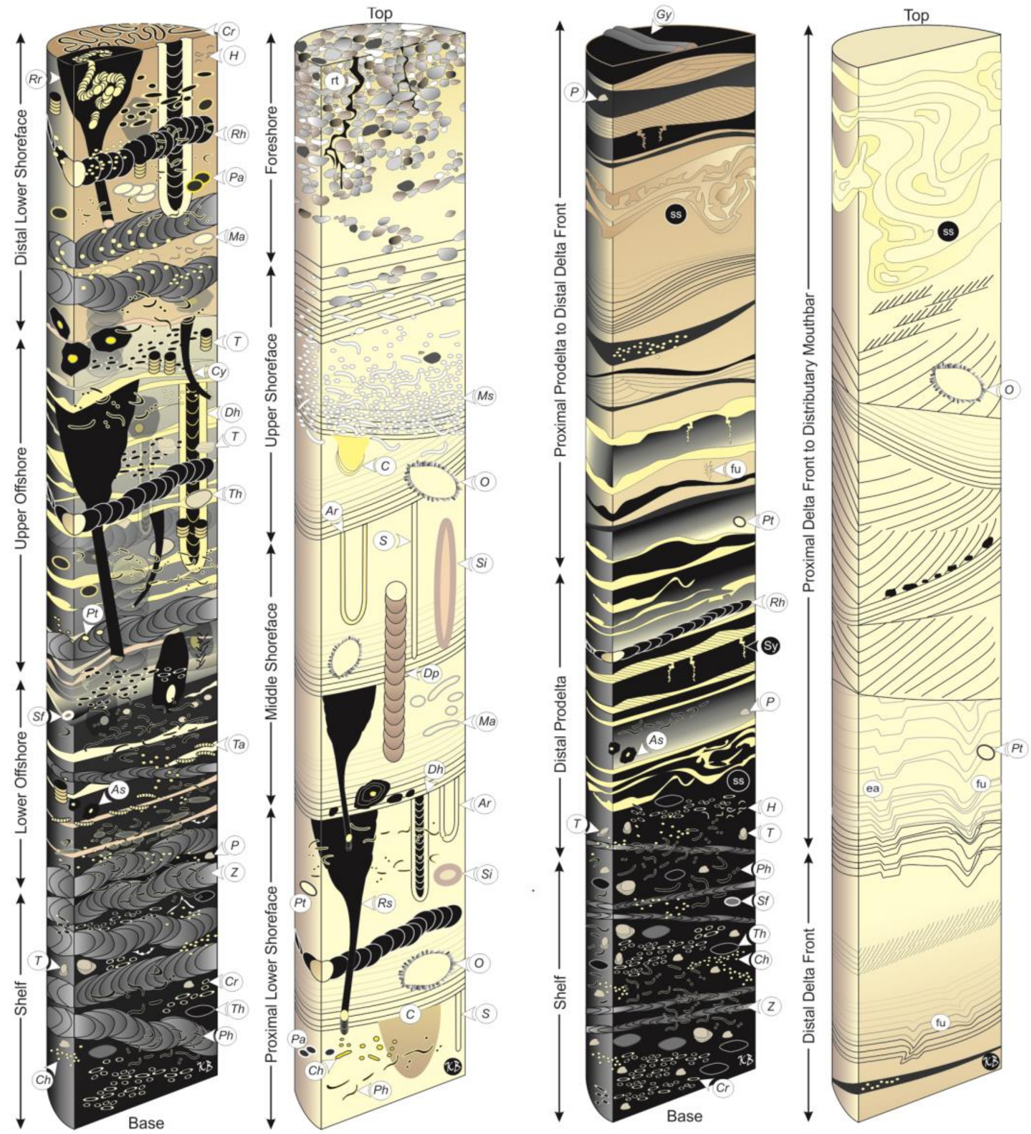
Mixed influence distal delta front deposits consist of interbedded fine-grained laminated sandstones with thin mudstone drapes. The facies are dominated by sharp-based hummocky-cross-stratified fine-grained sandstones commonly topped with oscillation ripples that are capped with phytodetritus-rich claystone drapes. Amalgamated hummocky-cross-stratification and thin normally graded beds occur locally. Phytodetritus is abundant along laminations. Claystone ripup clasts occur locally. Bioturbation is sporadically distributed with the BI ranging from 0 to 1-3 locally. The trace fossil assemblage is composed of deposit-feeding structures. Elements of the *Skolithos* Ichnofacies (*i.e.,* suspension-feeding structures) that would ordinarily be present in such sandy deposits are absent. This reflects the turbid nature of the deltaic setting that inhibits the activities of suspension-feeding activities.

Mixed influence proximal delta front deposits consist of laminated medium-grained sandstones. Laminations change from silty to carbonaceous upwards. Wavey-parallel laminations and oscillation ripples reflect wave influence whilst soft-sediment-deformation reflects rapid dumping of sediment during heightened fluvial dishcharge. Locally occurring claystone drapes reflect deposition via buoyant mud plumes. The deposits are predominantly unbioturbated but they are crypto-bioturbated reflecting the activities of micro-scale infauna that disrupt the laminations and give them a “fuzzy” appearance.

Mouthbar/terminal distributary channel deposits occur at the top of the deltaic parasequences and consist of a fining-upwards body of fine- to medium-grained sandstone with parallel and low-angle laminations, trough cross-bedding and current, combined and climbing current ripple-cross-lamination. Mudstone and siltstone laminations ranging from between mm scale and several cm are uncommon but occur locally. Carbonaceous detritus and mudstone rip-up clasts occur locally. Bioturbation occurs locally, mainly associated with the mudstone interbeds. All forms are deposit-feeding structures, diminutive in nature and include *Planolites* and *Teichichnus*. The assemblage represents a highly stressed expression of the *Cruziana* Ichnofacies.




(A): Pervasively bioturbated offshore deposit with diverse *Cruziana* Ichnofacies. *Thalassinoides (Th), Cosmorhaphe (Cr), Asterosoma, Rosselia (Ro), Planolites (P), Phycosiphon (Ph)*. (B): Heterolithic mixed-influence prodeltaic deposit. (C): Fine-grained sandy distal delta front deposits with claystone rip-up clasts and drapes. (D): Fine- to medium-grained proximal delta front deposit with carbonaceous laminae.




Split core diagrams displaying the characteristics of offshore/shoreface deposits as compared to wave-dominated deltaic deposits (MacEachern *et al.*, 2010).

## References

MacEachern, J.A., Pemberton, S.G., Gingras, M.K., and Bann, K.L., 2010. Ichnology and Facies Models. *Facies Models 4.* James N.P and Dalrymple R.W (eds), GEOtext 6 Geological Association of Canada, 19-58.

## Keywords

Wilrich, case study, integration, clastic sedimentology, ichnology.