

Depositional Architecture of the Lower Cretaceous Sparky, Waseca, and McLaren Formations, West-Central Saskatchewan, Canada

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The Lower Cretaceous Sparky, Waseca, and McLaren formations of west-central Saskatchewan, Canada, consist of weakly consolidated sandstones, shales, heterolithic bedsets, and minor coals. These units were deposited in low-gradient shallow-marine to coastal-plain environments, yielding thin cycles that reflect multiple, small-scale relative sea-level changes. Cores from 125 wells in the study area were evaluated for trace fossils, bioturbation index (BI), sedimentary structures, and evidence of stratigraphic discontinuities, leading to the identification of twelve recurring facies combined into 5 facies associations. The most common facies associations correspond to inclined heterolithic stratification (IHS), deltaic intervals (bay-head delta and bay-margin deltas), fluvio-estuarine valley fills, and coastal plain channels. Discrimination between these broadly similar facies requires the integration of sedimentological and ichnological data.

In the lower part of the succession, IHS deposits accumulated by lateral accretion in tidally influenced channels. Facies display BI 0-3, and contain ichnological suites dominated by Skolithos, Planolites, Gyrolithes, Cylichnus, navichnia and fugichnia, consistent with brackish-water accumulation.

Deltaic deposits are also heterolithic, with abundant, organic-rich fluid mud drapes, syneresis cracks, soft-sediment deformation features, carbonaceous detritus, normally graded beds, and structures recording oscillatory, current and combined flow processes. Facies display variable bioturbation intensities (BI 0-3), with low-diversity trace-fossil suites dominated by diminutive Gyrolithes, Teichichnus, Planolites, Palaeophycus, Cylichnus, Skolithos, Thalassinoides and Chondrites. Discriminating between bay-margin deltas and bay-head deltas can be challenging. Ichnological characteristics show bay-margin deposits to contain ichnogenera that reflect the activity of organisms considered intolerant of physico-chemical stress (e.g., Asterosoma, Phycosiphon and Helminthopsis). Stratigraphic correlation shows that bay-head deltas are confined within the valley fills. Distributary channels are associated with the deltaic deposits and are largely unburrowed (BI 0-2). Brackish-water bay deposits, into which the deltas prograde, display reduced physico-chemical stresses, manifest by the combination of higher bioturbation intensities (up to BI 5) and greater ichnological diversities than expressed by deltaic suites. This presumably reflects the reduced influence of river discharge into the setting. Bay successions contain Planolites, Cylichnus, Skolithos, Teichichnus, Palaeophycus, Thalassinoides, Chondrites, Asterosoma, Gyrolithes, navichnia and fugichnia, as well as wave- and combined flow-generated structures locally mantled with normally graded mud drapes and soft-sediment deformation features.

Valleys are incised up to 25m into palimpsest deltaic deposits, reflecting relative sea-level falls. Incised valleys were filled with fluvial to estuarine deposits during the subsequent transgression. Ichnological evaluation of the valley fills shows them to contain low-diversity suites consisting of small numbers of diminutive ichnogenera produced by trophic generalists, consistent with the brackish-water trace fossil model. BI values within the valley fills are generally low (0-2), but can reach up to BI 5 at the seaward limits of the study area.

The stratigraphic succession comprises parts of two depositional sequences. The lower sequence encompasses the Sparky and lower part of the Waseca formations, reflecting both transgressive and highstand systems tracts. During the Waseca, a lowstand disconformity was produced, with lowstand to early transgressive systems tract accumulation confined to the incised valleys. A maximum flooding surface separates the upper Waseca from the McLaren Formation. The McLaren represents a return to regional shoreline progradation, corresponding to a highstand systems tract.

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