

# Depositional History of the Middle Devonian Winnipegosis Carbonate-Prairie Evaporite in the Saskatchewan Sub-basin

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## ABSTRACT

The depositional history of the Middle Devonian carbonate-evaporite succession in different sub-basins of the Elk Point Basin has been documented in the literature. However, no detailed stratigraphic studies for this succession in the Saskatchewan Sub-basin has been made. The fluctuation of basinal brine level and relative sea level in the open ocean to the north of the Elk Point Basin and their influence on the deposition of this carbonate-evaporite sequence are also not fully understood. Understanding this transition from fully marine condition to desiccation is important to the ongoing hydrocarbon exploration, potash exploitation and study of other carbonate-evaporite basins.

The depositional history of the Winnipegosis carbonate-Prairie evaporite succession in the Saskatchewan Sub-basin was reconstructed based on core descriptions, thin section examination, construction of cross sections and isopach maps, including additional seismic data from ongoing hydrocarbon and potash exploration using a sequence stratigraphic framework. The Winnipegosis carbonate and Prairie Evaporite in the Saskatchewan Sub-basin were deposited in multiple stages in response to fluctuations of the relative sea level in the open ocean to the northwest of the Presquile Barrier Reefs and/or rate of subsidence of the Sub-basin. These stages can be correlated with the different lithologic units of the Keg River carbonate-Muskeg evaporite succession in the Northern Alberta Sub-basin.

The first stage of deposition consists of the Ashern Formation and the Lower Winnipegosis Member during relative sea level rise. The organic rich laminae of the Brichtholme Member were deposited where the Lower Winnipegosis Member is less than 12 meters. Continued relative sea level rise resulted in the formation of the Upper Winnipegosis Member, which is differentiated into platform, platform margin and basinal sediments in the Saskatchewan Sub-basin.

Deposition of the Winnipegosis reef mounds was terminated by a relative sea level drop that exposed the tops of the higher reef mounds. Karstification and vadose deposits formed in the upper parts of the Winnipegosis reef mounds during this time. In the basinal area, the Ratner Laminae were deposited in shallowing upward cycles. The Whitkow Anhydrite, however, was deposited adjacent to the fully developed reef mounds but a thick succession of halite of the Lower Prairie Evaporite precipitated away from the reef mounds during

early relative basinal brine level drop and the following relative basinal brine level rise. The anhydrite/carbonate cycles of the Shell Lake Member and Quill Lake Marker Beds in the study area are interpreted to form during the relative rise of sea level in the open ocean and uplifting of the Saskatchewan Sub-basin. The Winnipegosis reef mounds were also subjected to early anhydritization during this punctuated relative sea level rise. The Upper Prairie Evaporite and potash units are interpreted to form during basinal brine level rise and/or fast subsidence of the Sub-basin under a very arid climate. At that time, the relative sea level in the open ocean to the northwest of the Presquile Barrier Reefs is interpreted to be relatively stable or continuously increasing.