

## **Basin Dynamics of the Midale Member of the Charles Formation in the Williston Basin**

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### **Abstract**

The Mississippian aged Midale member of the Charles formation is in the Williston Basin. The stratigraphic succession in generalized terms from base to top comprises the Vuggy, Middle Marker and Marly beds. These beds overly the Frobisher Evaporite and underly the Three Fingers bed. The individual beds are differentiated from one another by the contrasting facies assemblage as described herein. The Vuggy Bed facies in order of abundance include 1.) Skeletal packstone – bivalves, crinoids, coral fragments, brachiopods broken and abraded into millimetre sized particles. Interparticle and vuggy porosity. 2.) Sandy skeletal wackestone – skeletal fragments mixed with fine sand sized grains, anhydritic cement overgrowths around particles reduce interparticle porosity. 3.) Coated-grain packstone – coated grains, peloids, calcrite crusts, rhizcretions, and burrows. Vuggy and fenestral porosity. 4.) Ooid-skeletal packstone – ooids, mixed skeletal debris composing crinoids, brachiopods and bivalves. Interparticle porosity. The Middle Marker facies comprise 5.) Skeletal floatstone – Large centimetre sized bivalves and coral fragments. Eutrophic (organic nutrient rich) carbonate mud matrix. 6.) Siltstone – Fine silt sized grains, commonly bioturbated, interbedded with dolomitic and calcitic mud. The Marly facies comprise 7.) Dolomudstone /dolowackestone – dolomitized skeletal fragments, dolomitized mud. This facies has intercrystalline and interparticle porosity. 8.) Lime mudstone/ wackestone – skeletal fragments broken and abraded into fine and sized particles. Interbedded by bioturbated silt, this facies has interparticle porosity. The Three Fingers facies comprise 9.) Dolomudstone – dolomitized mud with a mottled texture, mottling is due to both bioturbation and rhizcretions. This facies is commonly laminated. The porosity is occluded by anhydritic cement overgrowths. The Midale Evaporite comprises 10.) Anhydrite – Massive to laminated anhydrite, interbedded by shales and dolomudstone. Basin-wide genetic units representing correlative depositional units, yield evidence of subaerial exposure to the basin edge in the north that pass into shallow subtidal depositional environments to the basin center. The geometry of each Midale bed shows evidence of a tidal flat system, with internal geometries and sedimentological evidence of ebb and flood channels that are controlled by the underlying Frobisher Bed structural system. Furthermore, the Vuggy shallow marine system, the Middle Marker lagoonal system, and the restricted marine Marly reflect - the development of a barrier system to open marine circulation, and subsequent sediment infill. The distinct bed sets feature erosional surfaces, that are common features throughout Mississippian aged sediments of the Williston Basin. However, major erosional events overlain by mixed transitional zones are apparent under the Vuggy, Three Fingers and Midale Evaporite. This is evidence that the Vuggy, Middle Marker and Marly are somewhat continuous systems with minor erosional and depositional hiatuses. Whereas the Three Fingers is separate from the Midale Beds and represents a distinct supratidal depositional system that infilled the accommodation provided by the erosion of the Midale Beds. This erosive sequence is repeated with the overlying Midale Evaporite. Interestingly, the typified ramp system which incorporates terrestrial to deepwater systems is not preserved. The Williston Basin only has evidence of the terrestrial and nearshore depositional environments. Coinciding with the thickest Midale package preserved in the northern portion of the basin, located in present day Saskatchewan. There is no evidence of a correlative deepwater system containing shelf canyons, deepwater channels and splays, contourites, or turbidites, that would be expected in a true ramp setting within a basin-wide scale.