Deposition of the Middle Cambrian Deadwood Formation and the Initiation of the Williston Basin

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Abstract

This core display will focus on the Geology of the Middle Cambrian Deadwood Formation sands for CO_2 disposal (CCUS)and Geothermal Energy because of its depth of burial and reservoir quality and absence of hydrocarbons. We will also look at how gas is trapped in Lower Ordovician Winnipeg Formation (Black Island Member). In order to understand the sequence of events that led up to deposition of the Middle Cambrian Deadwood Formation, we must first look at the early tectonic history of western North America. The Churchill (Sask Craton) was subducted beneath the Superior Craton during Paleo-Proterozoic collision to create a Himalaya type mountain chain (Corrigan, 2012). The Late Proterozoic Grenville Orogeny during the docking of Rodinia Super-continent resulted in the creation of the Trans Continental Arch being superimposed on this subduction zone. Laurentia ended up near the equator after the breakup of Gondwana during lower Cambrian. The Continent was progressively flooded during Lower Cambrian and was dominated by carbonate deposition. Clastics sourced in Manitoba were transported southward along strike in the collision zone and constrained by the Trans Continental Arch. The Deadwood Formation environment of deposition was very similar to the Modern Florida Peninsula carbonates and the Gulf of Mexico Mississippi Delta/ Longshore drifted Barrier Bar clastics. In Oliver County, North Dakota, the Minnkota JROC-1 (Lic. #37672) reservoir is interpreted as a Baymouth Bar associated with longshore drifted clastics within a carbonate regime. These sands are tidally influenced and show good evidence of high energy bidirectional flow currents and truncated burrows. The Deadwood Formation pinches out onto the Trans Continental Arch in South Dakota (Fox, et al, 2009). The Deadwood Formation was subsequently subjected to extensive erosion and the large, incised valley marked the initiation of the Williston Basin. The entire Deadwood section was eroded within the incised valley and valley fill started in Middle Ordovician with deposition of the Winnipeg Formation (Black Island Member) Longshore Drifted Barrier Bar clastics. Initiation of the Red River Carbonate Platform and deeper water organic-rich Winnipeg Formation (Icebox Member) occurred as the water deepened. Gas is trapped in the McKeen 30-23 Antelope Pool Well (McKenzie Co.) in basal Winnipeg Formation (Black Island Member) longshore drifted Barrier Bar sands (North Dakota lic. #13589). The unconformity on the Deadwood acts as a bottom seal for the hydrocarbons and the top of the sand is truncated by a Transgressive Surface of Erosion (figure 3). A similar scenario traps oil in the Hartaven Pool in southeast Saskatchewan (12-1T-10-9W2M, Lake and Marsh, 2021).