

Lower Devonian Arnica Formation as Reservoir in a Conceptual Play; Peel Plateau and Plain, Northwest Territories and Yukon

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Summary

The Lower (to Middle?) Devonian Arnica Formation is widespread throughout the subsurface of Peel Plateau and Plain (Peel region). Examination of outcrop exposures, and measurement of stratigraphic sections along the Mackenzie Mountain Front adjacent to Peel area, has largely confirmed earlier work. Arnica Formation is chiefly dolomite mudstone, often laminated or strongly bioturbated; and indicative of shallow marine platform or shelf depositional environment.

At its eastern limit, there is a facies change to correlative anhydritic evaporite deposits of Fort Norman Formation. Outcrop exposures of Arnica Formation, across the transition from dolomite to dominantly evaporite, display increasing amounts of breccia. These breccias have been proposed by previous workers to be at least partly due to dissolution and collapse of evaporite interbeds within the dolomite – anhydrite sequences. The common term for the map-scale massive breccia unit is Bear Rock Formation.

At its western limit, limestone is more commonly preserved, typically in fossil rich packstone, wackestone, and less common boundstone biostromes. Fossil assemblages are dominated by crinoids, brachiopods, colonial corals, stromatoporoids, solitary corals and gastropods. These fossiliferous limestone units of Arnica Formation have been termed Cranswick Formation in the literature. Near the western margin of Peel region, Arnica Formation carbonate rocks shale out into basal Road River Group shale.

Arnica Formation exhibits some good reservoir properties in localized beds throughout its areal distribution. Medium grained sucrosic dolomite, with porosity up to 6.1%, is common in decimeter to metre scale beds, with gross intervals of usually several metres in many locations. Arnica breccia beds, as well as the massive Bear Rock breccias, are also porous (6% porosity). In southwestern Peel region, surface exposures of limestone biostromes did not show particularly good primary porosity, however porosity may be enhanced by secondary agents in the subsurface.

From a petroleum systems standpoint, source rocks for Arnica Formation reservoirs are more problematic. In the west, Road River Group shale is overmature. There are few if any organic shale interbeds within Arnica Formation, nor within overlying (Landry Formation limestone) nor underlying (Delorme Group silty carbonates) units. However in eastern Peel area, a mature source rock did exist, and migration did occur, as evidenced by oil-stained Arnica dolomite and Bear Rock breccia at Stratigrapher Cliffs and Powell Creek. Middle to Upper Devonian shales (Hare Indian, Ramparts, Canol formations) are the likely sources.

Further work will continue with an aim of outlining possible Arnica play fairways. At this point it seems that structural traps may be important in juxtaposing mature source rocks and Arnica reservoirs. However, the timing of petroleum formation and migration with respect to formation of these structural traps, may pose further exploration risks.