

To the Northeast or to the Northwest: Flow of Formation Waters in the Devonian Succession in the Peace and Athabasca Rivers area in Northeastern Alberta

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The predominantly carbonate Devonian succession in northeastern Alberta in the area defined by 54-58°N and 112-116.5°W consists of a series of aquifers (Keg River, Beaverhill Lake, Cooking Lake, Grosmont, Nisku and Wabamun), separated by intervening evaporitic aquicludes and shaly aquitards (Prairie, Ireton and Graminia). Except for the lowermost Elk Point Gp., all the strata subcrop from the west to east with increasing age at the sub-Cretaceous unconformity, and are overlain by Cretaceous Lower Mannville sandstones. The Beaverhill Lake Gp. carbonates crop out along the valleys of the Athabasca River in the east and the Peace River in the northeast, while the Grosmont Fm. crops out in the northwest at the Peace River. The salinity of formation waters in these aquifers varies in a wide range, from <20,000 in areas where aquifers subcrop at the sub-Cretaceous unconformity in the north-northeast to >350,000 mg/l in the vicinity of halite beds in the Keg River aquifer. The density of formation waters in the Upper Devonian varies accordingly between 997 kg/m³ and 1100 kg/m³, while in the Middle Devonian it reaches up to 1250 kg/m³. Hydraulic heads calculated with an average reference density of 1050 kg/m³ show two divergent main flow systems in the Devonian aquifers in the area, both originating in the SW. One system is oriented to the NE, toward outcrop near the exposed Precambrian Shield and along the Athabasca River. The second system turns around to the NW, toward discharge at the Peace River. The flow in the Devonian aquifers in the area is controlled by aquifer geometry, high permeability pathways and boundary conditions at discharge.