

## Hydrogeological Characterization of Basal Paskapoo Sandstones in the Subsurface of West-Central Alberta

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The Tertiary Paskapoo and equivalent Porcupine Hills formations form a vast eastward-thinning wedge of nonmarine sediments deposited into the Western Canada Sedimentary Basin, derived from the emergent Cordillera. Paskapoo strata crop out or lie beneath Quaternary sediments over southern and central portions of west-central Alberta. Preserved thicknesses are about 750 metres in the Calgary area, and up to 1500 metres on the Oldman River in southern Alberta.

Recent regional studies by the Alberta Geological Survey have created a solid regional understanding of the Paskapoo and its constituent members (e.g., Parks and Andriashek, 2009; Lyster and Andriashek, 2012). The basal Haynes Member crops out in central Alberta as cliff-forming, stacked, thick medium- to coarse-grained fluvial sandstone beds, lying sharply on fine-grained, coal-bearing floodplain strata of the uppermost Cretaceous Scollard Formation. The overlying Lacombe Member is dominated by fine-grained floodplain strata with relatively rare and discontinuous channel sandstones. The capping Dalehurst Member (also known as the Sunchild) also consists largely of fluvial channel sandstones, but is less known because of its limited geographic distribution.

In a regional study of subsurface aquifers in the Montney and Duvernay unconventional play fairways in west-central Alberta, Petrel Robertson mapped basal Paskapoo sandstones (subsurface equivalents of the Haynes) regionally through west-central Alberta, based on selected petroleum borehole control. Total thickness maps of the basal Paskapoo sandstone shows pronounced SSW-NNE thicks, ranging from >200m thick in the Foothills to 75-100m in the east. This map was hand-contoured to maximize continuity of the sands, which we have interpreted as profound channelized fairways, distributing sediment from western highlands eastward into the foreland basin. While there are very few zero thickness values, broad areas in the northeast feature less than 25m basal Paskapoo sandstone thickness. Net porous sandstone mapping (using 75 API gamma log and 15% sandstone density cutoffs) shows similar patterns, but burial compaction generally reduces porosities westward.

Grasby *et al.* (2008) estimated that about 64,000 water wells (roughly one-third of water wells completed in Alberta up to August 2006) are located in the Paskapoo outcrop belt, and that the Paskapoo is the most significant supply of groundwater in the Canadian Prairies. Regional hydrogeological analyses of the Paskapoo in the past have focused on abundant data from shallow water wells, or have addressed larger stratigraphic intervals including Upper Cretaceous strata. Focusing on the “deep” Paskapoo (>100m deep, in petroleum boreholes), we found 22 valid drillstem tests from 20 wells testing basal Paskapoo sandstones, which appear to define two regional water systems. Ten valid water analyses yielded salinities ranging from 1567 to 2627 mg/L TDS – technically non-saline, but realistically non-potable. There are only 15 Basal Paskapoo water source wells from deep boreholes. Most were drilled in the 1960’s and 1970’s, and only two are active today. Cumulative water production values are relatively modest, with the top four wells having produced 0.43-1.40x10<sup>6</sup>m<sup>3</sup>, although three of these are situated in adjacent LSD’s in section 30-40-3W5 where net porous sandstones map at 50-75m thick.

In looking to the basal Paskapoo for water, one must be careful to avoid encountering gas; there are 83 Paskapoo gas wells in the study area. The best cumulative production is 68.9 e<sup>6</sup>m<sup>3</sup> (2.43 BCF) over 12 years, while 11 wells have produced >0.5 BCF (14.2 e<sup>6</sup>m<sup>3</sup>). A number of wells were perforated over several intervals, including sandstones and shales in the Scollard Formation, so not all this production can be attributed to the Paskapoo.

## Conclusions

Regional mapping of “deep” basal Paskapoo sandstones (below depths penetrated by domestic and agricultural water wells) using petroleum borehole data shows huge volumes of high-quality aquifer rock, arranged in SSW-NNE channelized systems. These contain non-saline but largely non-potable waters, which have been accessed in only a small number of wells to date. Basal Paskapoo waters represent a huge, untapped potential resource that could be used to support unconventional oil and gas drilling and completion activity, while not competing with domestic and agricultural needs.

Much more intensive work is required to complete assessment of this resource with sufficient detail and accuracy to assure both operators and the Regulator that the basal Paskapoo is a viable, sustainable aquifer target.

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