

# Unusual calcium-rich formation-waters from Devonian aquifers in the Western Canada Sedimentary Basin: possible relict seawater?

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## ABSTRACT

There has been a lot of controversy regarding the question of secular changes in Phanerozoic seawater and whether seawater chemistry has remained similar to today (i.e., Mg-SO<sub>4</sub> type) or was for periods of time of fundamentally different composition (i.e., Ca-Cl<sub>2</sub> type). This issue has been exacerbated by many studies of formation-waters collected from geologic basins that have failed to find evidence of widespread Ca-Cl<sub>2</sub> type brines, and have thus concluded there is little or no evidence to support Ca-Cl<sub>2</sub> type seawater during the Phanerozoic.

There are widespread, but aquifer-restricted Ca-Cl<sub>2</sub> type brines in the Alberta and Williston basins (Western Canada Sedimentary Basin). Samples include: two producing wells in the Alberta Basin; a potash mine-shaft in the Williston Basin; multiple unpublished Drill-Stem-Test data from the Williston Basin; and previously-known (albeit re-sampled and further analyzed) samples from potash mine-shafts in the Williston Basin. These samples are from aquifers of roughly similar (Devonian) stratigraphic age when seawater was reportedly of the Ca-Cl<sub>2</sub> type.

Results from across the basin are remarkably similar: calcium-chloride type brines (TDS > 425 g/L); calcium > 120 g/L; chloride >270 g/L; magnesium > 11 g/L; potassium >6 g/L; sodium < 10 g/L; bromine >6 g/L; and sulfate <100 mg/L. These data along with stable isotopic measurements and analyses of the regional hydrogeology of the basin support the conclusion that these samples are relatively unaltered highly evaporated Devonian seawater. Assuming that bromine has been relatively conservative in seawater through time, an evaporation factor can be calculated and then used to estimate the composition of the original Devonian seawater. The unique stratigraphic position of the host Devonian aquifer combined with the paleo-hydrogeology of the basin, has combined to preserve these fluids to the present time.