

Hydrochemistry of the Bakken aquifer in the Williston Basin – Canada and USA



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ABSTRACT

Chemical composition and distribution of formation waters in the Bakken aquifer were investigated to understand their origin, migration, and evolutionary history. A basin-wide geochemical database was created, composed of nearly 2000 water analyses from drill stem tests, initial production recoveries, and wellhead production samples. An extensive, iterative culling procedure was used to remove all non-representative formation water analyses. From the remaining 167 water analyses, a detailed hydrochemical investigation was performed including total dissolved solids (TDS) content and distribution, hydrochemical facies classification and distribution, and formation water origin utilizing Na-Cl-Br systematics. Results show that the water composition and salinity within the Bakken aquifer is variable throughout the Williston Basin with TDS ranging from less than 10,000 mg/l, to over 300,000 mg/l towards the center of the basin. Formation waters from the Bakken aquifer are dominantly Na-Cl type however, Na-SO₄ type formation waters occupy the northwest of the study area near the transition of the Bakken Formation of the Williston Basin into the Bakken/Exshaw Formation of the Alberta Basin. Brine origin as determined from Na-Cl-Br systematics performed on Na-Cl type formation waters reveal that Bakken Formation brines are of multiple origins. In the center of the Williston Basin, Bakken aquifer formation waters obtained their salinities from the evaporation of paleo-seawaters and appear to be near-relict connate water. Bakken Formation brines located outwards from the center of the basin show a mixing between brines resulting from halite dissolution as well as those from the evaporation of paleo-seawater. The overall distribution of formation waters in the Bakken aquifer today reflects a complicated mix of original connate brines mixing with salt-dissolution waters transported by a regional groundwater flow system.

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