

Province Wide Hydrogeological Characterization Mapping of Saskatchewan; the Northeastern Margin of the Williston Basin and the Eastern Margin of the Alberta Basin

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Abstract

Fluid migration, water chemistry and hydraulic heads play a major role in hydrocarbon migration and entrapment. In recognition of this basic concept, the Government of Saskatchewan initiated a province wide hydrogeological and geological mapping project in 2009. The Saskatchewan Phanerozoic Fluids and Petroleum Systems Assessment (SPFPS) was designed to better understand the movement of fluids and the regional geology in the province of Saskatchewan. One of objectives was to complete the hydrogeological characterization of the province utilizing previous hydrogeological studies completed at the University of Alberta, and mapping portions that had yet to be done and to then compile all the information to form a series of hydrogeological maps for the entire province of Saskatchewan.

The Saskatchewan geological framework was refined into a hydrostratigraphic column consisting of 19 major aquifers and 13 aquitards. Detailed mapping of hydraulic head and water chemistry has been conducted on aquifers ranging in age from Cambrian to the upper Cretaceous. A strict culling process of the raw data was completed to eliminate contaminated, poor quality, and production influenced samples. Flow directions determined from maps of equivalent fresh-water hydraulic-head indicate generally that flow conditions are updip from SW to NE across the province. Mapped formation water salinities range from 2 to 471 g/L and indicate significant density variations between formations and across the province. Four distinct formation water types are identified based on ion chemistry: (1) Ca-SO₄ fresh, (2) Na-SO₄ brackish, (3) Na-Cl brines, and (4) Na-HCO₃ fresh waters brines.

This province wide hydrogeological characterization has provided new insights into the vertical and spatial distribution and mixing of formation waters. The interaction between the two converging basins is also seen in flow patterns of relatively fresh formation waters and highly saline brines. The results from this mapping will help in a better understanding of the fluid migration in the province as well as aid in investigating reservoir response for enhanced oil recovery techniques such as water flooding and injecting CO₂.