Hydrogeology of Phanerozoic strata in Saskatchewan: Province-wide Hydrogeologic Mapping

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ABSTRACT
Subsurface fluid migration and water chemistry play a major role in hydrocarbon migration and entrapment. A province-wide hydrogeological and geological mapping project (Saskatchewan Phanerozoic Fluids and Petroleum Systems Assessment) was conducted to integrate the regional geology, hydrogeology, and hydrochemistry of Phanerozoic formation-fluids across Saskatchewan. One main objective of the project was to use a consistent geological framework to combine all previous hydrogeological maps and fill missing areas to create complete maps for the province of Saskatchewan.
The subsurface geological framework of Saskatchewan was refined into a hydrostratigraphic column consisting of 14 major aquifers. Detailed mapping of hydraulic head and water chemistry for aquifers ranging in age from Cambrian to the upper Cretaceous was completed. Hydrochemistry was mapped after using a culling process on the raw data to eliminate non-representative samples. 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-SO_4 fresh, (2) Na-SO_4 brackish, (3) Na-Cl brines, and (4) Na-HCO_3 fresh waters brines. Fluid flow directions were determined using measured pressures that were culled to remove production-influenced values. Distributions of equivalent fresh-water hydraulic-head indicate generally that flow conditions are up dip from SW to NE across the province. Density corrected water driving force (WDF) maps were constructed to identify areas where density dependent flow is significant. These WDF maps will help to elucidate migration patterns within the province.
This hydrogeological characterization provides new insights into the spatial distribution and mixing of formation waters. Results from this project will provide 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 CO_2 injection.