Regional Hydrogeological Characterization in the North Eastern Margin of the Williston Basin, Saskatchewan-Manitoba, Canada

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The Williston Basin hosts one of the largest regional groundwater flow systems in North America. Understanding the regional hydrogeology is essential because fluid flow has influenced its mineral and oil/gas deposits. Previous hydrogeological studies in the basin have not been integrated across provincial boundaries and have used an outdated geological framework. Thus a new hydrogeological characterization of the entire geological section has been undertaken to identify driving forces, determine flow directions/rates, and characterize the composition and distribution of subsurface waters in the basin.

A newly-developed 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. Flow directions determined from maps of equivalent fresh-water hydraulic-head indicate dominantly updip flow of formation waters from SW to NE across the study area. Mapped formation water salinities range from 2 to 471 g/L and indicate significant density variations between formations and across the area. Five distinct formation water compositions are identified on the basis of major ion chemistry: (1) Ca-SO_4 fresh, (2) Na-SO_4 brackish, (3) Na-Cl brines, (4) Ca-Cl brines, and (5) Na-HCO_3 fresh waters. Density-dependent fluid flow is important in certain aquifers because downdip flow decreases the upward driving force for cross-formational flow and enhances hydrocarbon trapping capacities. Cross-formational flow associated with the salt dissolution edge of the Prairie Evaporite Formation has resulted in dissolution features in/above Mississippian formations.

This regional hydrogeological characterization has provided new insights into the vertical and spatial distribution of mixing formation waters, the basin's response to glaciation and

sub-glacial recharge waters, and provides an explanation for the geochemistry of saline springs recognized in the discharge zone.