

Geological, hydrogeological and numerical models of the transboundary Milk River Aquifer system (Alberta, Canada - Montana, USA)

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ABSTRACT

The Milk River Aquifer (MRA) is a regional confined sandstone aquifer (26,000 km²), spanning southern Alberta (Canada) and northern Montana (USA). Previous studies were limited by the international border, thus preventing a complete understanding of the global dynamics of the aquifer. The present study overcomes transboundary limitations by providing a comprehensive portrait of the aquifer. The stratigraphic framework of the study area was first unified in a geological model of the aquifer system. Then, the conceptual hydrogeological model of the MRA was developed by gathering hydrogeological and geochemical data from both sides of the Canada/USA border. Recharge occurs in the subcrop areas of the aquifer, where unconfined conditions and modern waters are present. Groundwater inflow into the MRA also occurs from overlying geological units in the topographic highs of the area. Two transboundary fluxes were defined from the potentiometric map of the aquifer, which closely mimics the topography. The Milk River intercepts a major part of the groundwater flux coming from the south. Another natural discharge mechanism corresponds to vertical leakage through the aquitards, especially along the bedrock valleys, which act as drains. The geological and conceptual models of the MRA form the basis of the numerical groundwater flow model of the aquifer. The 3D steady-state groundwater flow model represents pre-development conditions. The numerical model shows that the conceptual model of the aquifer is hydraulically plausible by successfully representing the main components of the conceptual model and the groundwater budget. Furthermore, the numerical model quantifies the vertical fluxes through the aquitards as well as the groundwater inflow from the overlying units near the topographic highs. Being a transboundary groundwater resource, a joint management of the MRA would be warranted, especially in the area between the recharge area in Montana and the southern reach of the Milk River in Alberta.

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