Evaluation of groundwater flow systems in Wood Buffalo National Park using field chemistry, hydrochemical facies and groundwater flow models

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Wood Buffalo National Park (WBNP) is Canada's largest national park, approximately 45 000 km^2 in areal extent. It exhibits classic examples of surface phenomena thought to be associated with groundwater discharge, such as springs with variable and distinct chemical compositions, extended salt plains and/or phreatophytic plant communities. Our working hypothesis is that groundwater flow in the Park is controlled by water-table relief and observed surface phenomena reflect the different orders and segments of groundwater flow systems.

Over 500 chemical analyses of surface waters and springs were used to determine the hydrochemical characteristics of WBNP (e.g., total dissolved solids, TDS) and to develop a hydrochemical facies classification in WBNP. The hydrochemical analyses of surface waters and springs revealed significant variability in TDS and hydrochemical facies. TDS ranges from less than 1,000 mg/L to more than 300,000 mg/L. The hydrochemical facies show examples spanning the entire Chebotarev-sequence including end-members of young Ca-HCO_3-type to more evolved Na-Cl-type waters.

Numerical models of groundwater flow were developed to quantify the flow field and to identify recharge and discharge areas in selected regions. Comparison of numerical simulations with field data indicated strong correlations between the modelled flow fields and the chemical character of surface water samples. For example, Ca-HCO_3-type waters with low TDS correspond with discharge areas of local flow systems and Na-Cl-type waters with high TDS are found in discharge areas of regional systems.

The results suggest that differences in water chemical character are good indicators of different orders and segments of groundwater flow systems in WBNP and can, therefore, be considered manifestations of topography-driven groundwater flow.

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