Occurrence, sources and fate of nitrate in groundwater of agricultural watersheds in southern Alberta, Canada

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Providing high-quality drinking water is of key importance for supporting an increasing global population. While shallow groundwater is often a key source of water for domestic and livestock use in many regions, nitrate contamination of shallow aquifers is a widespread problem in many countries with the potential for adverse health effects if the water is used for drinking water purposes. We have investigated the quality and geochemical evolution of groundwater in agricultural watersheds of southern Alberta, Canada. A key objective was to determine the occurrence, the sources and the fate of nitrate in groundwater in agricultural watersheds using a combination of geochemical, isotopic and microbiological approaches.

Groundwater samples were collected from hundreds of domestic and monitoring wells completed in shallow aquifers (< 150 m) in agricultural regions of the province of Alberta, Canada. For all groundwater samples, concentrations of major and minor ions, total dissolved solids (TDS), water types, and redox states were determined. Nitrate concentrations above the detection limit were found in 35% of the groundwater samples. Only in 3 % of the samples did nitrate exceed the maximum allowable concentration for drinking water of 10 mg/L NO_3^--N. The isotopic composition of nitrate revealed that high nitrate contents in groundwater are frequently the result of cattle manure applications. Chemical, isotopic and microbial data revealed that denitrification was an important nitrate removal process in some aquifers that frequently contain moderately to highly reducing groundwater. The commonly reducing conditions explain why most groundwater samples had low, negligible or non-detectable nitrate concentrations.

In summary, this study revealed that the combination of geochemical, isotopic and microbiological approaches is a powerful tool to investigate the occurrence, origin and fate of groundwater contaminants such as nitrate with health implications for humans, livestock and ecosystems.

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