Investigating the use of chlorine stable isotopes to identify sources of chloride in stream water

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Chloride is often assumed to be a conservative ion in the hydrological cycle and is used as a tracer ion to represent marine input via atmospheric deposition to inland fresh waters. Consistently observed discrepancies between measured catchment deposition chloride input and stream water exports are often resolved by inferring that the excess chloride enters watershed systems as unmeasured fog and/or dry deposition. The application of chloride as a marine tracer has been verified to some extent in watersheds close to the ocean where sea spray is easily measured. However, chloride deposition as aerosols or fog has not been measured and quantified for watersheds further inland. Chlorine stable isotopes offer a new method to distinguish sources of chloride in stream water. Values of chlorine stable isotopes are reported as $\delta^{37}Cl$, a ratio of ^{37}Cl / ^{35}Cl in reference to Standard Mean Ocean Chloride. Analytical uncertainty resulting from daily repeat analyses of seawater is better than 0.26‰ (1σ) and represents uncertainty from sample preparation and instrument precision. In southwestern Nova Scotia, the chlorine stable isotope composition of fog (-1.71‰ to -0.21‰), precipitation (-2‰ to -1‰), soil solution of B and C horizons (-1.57‰ to -0.81‰), mineral-bound chloride of soil and bedrock (-0.96‰ to +2.3‰), and stream water of two watersheds (-1.5‰ to -0.5‰) confirms that precipitation is not the sole contributor of chloride to stream water. Results suggest both fog and bedrock could be significant contributors to the chloride budget of these streams.

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