Relationships Between Stream Acid Anion-Base Cation Chemistry and Watershed Soil Types on the Allegheny High Plateau

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Poster Abstract

The leaching of calcium and magnesium from forests by atmospherically-deposited strong acid anions (sulfate and nitrate) is evidenced in some watersheds by the positive correlation in stream water between concentrations of these base cations and acid anions. However, in other watersheds, stream concentrations of base cations and acid anions are negatively correlated, even where acidic deposition is high. The goal of this study was to determine if base cation-acid anion relations in headwater streams were related to proportions of soils with shallow perched water tables (SWT) and soils without perched water tables in a watershed. I sampled stream water from 18 forested watersheds in the Allegheny National Forest, Pennsylvania, between August 1996 and June 1997. I placed each watershed into one of three groups according to the base cation-acid anion relationships of its primary stream: (1) positive correlation between base cations and acid anions ($p \leq 0.05$; $n=10$), (2) negative correlations between base cations and acid anions ($n=4$), or (3) either a combination of positive and negative correlations or no significant relationship between base cations and acid anions($n=4$). Percentages of watershed area covered by soils with shallow perched water tables (%SWT) differed significantly (ANOVA, $p=0.01$) among the three groups of watersheds. The percent of the watershed covered with SWT for positively correlated cation-anion relationships was significantly greater ($p<0.05$, Scheffe test) than the percent of the watershed area with SWT for negatively correlated cation-anion relationships, and was marginally ($p=0.055$) greater than the percent of watershed area covered by soils with SWT for mixed or non-significant cation-anion relationships. In two watersheds covered mostly (80-90%) by soils with shallow perched water tables, the streams were flashy (*i.e.*, streams rose quickly in response to precipitation inputs) and calcium, magnesium, and sulfate concentrations all increased similarly with increasing discharge. In contrast, at a watershed with < 32% of its area covered by soils with shallow perched water tables, the stream was less flashy, and base cation concentrations declined sharply with increasing discharge, even though sulfate concentrations increased and nitrate concentrations remained essentially unchanged. These results suggest that flowpaths of groundwater that contribute to stream water are influenced by physical properties of soils in the watershed: where an impermeable layer (e.g., a fragipan) supports a perched water table, most stream water might originate from soil horizons above the impermeable layer. However, where impermeable layers are less extensive, stream water might originate mostly from deeper (more base-rich) groundwater at low flow and shallower (more acidic, base-dilute) groundwater at high flow (e.g., after storms).

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