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Response of a first-order stream in Maine to short-term in-stream acidification

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Abstract. An experimental short-term acidification with HCl at a first-order stream in central Maine, USA was used to study processes controlling the changes in stream chemistry and to assess the ability of stream substrate to buffer pH. The streambed exerted a strong buffering capacity against pH change by ion exchange during the 6-hour acidification. Streambed substrates had substantial cation and anion exchange capacity in the pH range of 4.1 to 6.5. The ion exchange for cations and SO_4^{2-} were rapid and reversible. The speed of release of cations from stream substrates was $\text{Na}^{1+} > \text{Ca}^{2+} > \text{Mg}^{2+} > \text{Al}^{3+} > \text{Be}^{2+}$, perhaps relating to charge density of these cations. Ca^{2+} desorption dominated neutralisation of excess H^+ for the first 2 hr. As the reservoir of exchangeable Ca diminished, desorption (and possibly dissolution) of Al^{3+} became the dominant neutralising mechanism. The exchangeable (and possibly soluble) reservoir of Al was not depleted during the 6-hour acidification. Sulphate adsorption during the acidification reduced the concentration of SO_4^{2-} in stream water by as much as $20 \mu\text{eq L}^{-1}$ (from $70 \mu\text{eq L}^{-1}$). Desorption of SO_4^{2-} and adsorption of base cations after the artificial acidification resulted in a prolongation of the pH depression. The streambed had the capacity to buffer stream water chemistry significantly during an acidifying event affecting the entire upstream catchment.

Keywords: stream acidification; ion exchange; sediment; sulfate exchange; aluminium; beryllium

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