Sourcing streamwater Ca following clear-cutting of a New England watershed

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Clear-cutting of a forested watershed results in increased hydrologic export of important nutrients including Ca, but the internal sources and mechanisms of Ca that lead to increased export remain uncertain. Ca isotope ratios, which are fractionated in forest ecosystems by preferential uptake of light Ca by plants, may allow us to determine the forest Ca pools that contribute to increased export.

We measured stable Ca isotopes on archived precipitation, soil, bedrock and streamwater samples from two Hubbard Brook watersheds, one of which (Watershed 5) was subjected to a 1983 whole-watershed harvest experiment. The other watershed (Watershed 6) was untreated and serves as a control. δ^{44}Ca of precipitation (-0.93‰ relative to the seawater standard) and silicate bedrock (–1.28‰) are typical of rainfall and bedrock measured globally. Soil exchangeable δ^{44}Ca is very light at the surface (-1.84‰ at Oa horizon) reflecting recycling of biologically-fractionated Ca back into topsoil, and becomes heavier with depth (to –1.38‰ in the C horizon). Streamwater δ^{44}Ca in both watersheds varies within the range defined by precipitation and shallow soil Ca. In both watersheds, δ^{44}Ca generally becomes lighter with increasing discharge, consistent with rainfall-driven changes in flowpaths whereby streams export shallow-soil Ca at high flow.

As streamwater Ca concentrations increased ~5-fold in Watershed 5 following clear-cutting, average streamwater δ^{44}Ca decreased by ~0.3‰. Our working hypothesis is that this increased Ca export is made up of biologically cycled Ca from shallow soil. An increase in Watershed 5 streamwater Ca/Na ratios supports this interpretation. However, synchronous with the observed shift in Watershed 5 δ^{44}Ca, we observe a smaller, but still robust shift towards lighter δ^{44}Ca and higher Ca/Na ratios in the control Watershed 6. The mechanism for this is unclear, perhaps reflecting long-term changes in Ca cycling in this forest.