Calcium isotope fractionation in a boreal forest ecosystem

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A large range in the isotopic fractionation of Ca was found in a boreal forest study area near La Ronge in Northern Saskatchewan, thus confirming: (1) earlier findings that terrestrial vegetation fractionates Ca isotopes, and (2) the potential for isotopic tracing of Ca nutrient cycling in forests. The field site is a small ravine-like catchment with a single 1st order stream. Trees preferentially absorb the lighter isotopes of Ca from soil exchangeable reservoirs. Stem wood δ^{44} Ca ranged from -1.4 to -1.9%, compared to soil solutions representing the O and B-horizons, ranging from -0.9 to -1.2% (δ -values relative to seawater). Local precipitation δ^{44} Ca is -1.2%. By contrast, recent foliage samples were enriched in ⁴⁴Ca relative to both time-averaged stem wood and soil solutions, yielding δ^{44} Ca values ranging from -0.34 to -1.6. Enrichment of ⁴⁴Ca in leaves was confirmed for a red oak seedling grown in vivo on pristine powdered basalt, which yielded an isotopic difference of +0.8% between leaf and stem. The leaf-stem δ^{44} Ca differences in the field are smaller than this (0.2 to 0.5 %) and additional pot studies and fieldwork are needed to address potential and ontogenetic effects influencing vital the fractionations. In addition, there are local scale differences in the isotope balance of Ca between different stands of trees related to hill slope position that requires further investigation. The stream is the most uniform Ca isotope reservoir yet identified in the field area with a mean δ^{44} Ca = -0.66 ±0.13 (2 σ) based on 8 samples collected over a single season. The relatively high stream water value appears to reflect the time-integrated balance of ⁴⁰Ca uptake by trees and ⁴⁴Ca release by foliage throughout the watershed. These data will be incorporated into a Ca cycle model that will test interpretations and foster predictions.