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Use of foliar Ca/Sr discrimination and $^{87}Sr/^{86}Sr$ ratios to determine soil Ca sources to sugar maple and American beech foliage in a northern hardwood forest

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Ca/Sr and $^{87}Sr/^{86}Sr$ ratios in foliage can be used to determine the relative importance of different soil sources of Ca to vegetation, if the discrimination of Ca/Sr by the plant between nutrient sources and foliage is known. We compared these tracers in the foliage of sugar maple (*Acer saccharum*) and American beech (*Fagus grandifolia*) to the exchange fraction and acid leaches of soil horizons at six study sites in the White Mountains of New Hampshire, USA. In a previous whole-watershed $CaSiO_3$ addition experiment at the nearby Hubbard Brook Experimental Forest, sugar maple was shown to discriminate for Ca compared to Sr in foliage formation by a factor of 1.14 $\pm$0.12 and American beech was shown to discriminate by a factor of 1.92 $\pm$0.20. After accounting for the predicted 14% (sugar maple) and 92% (American beech) shifts in Ca/Sr, foliar Ca/Sr and $^{87}Sr/^{86}Sr$ ratios closely match the values in the Oie horizons at each study site across a $>$3-fold variation in foliar Ca/Sr ratios. Newly weathered cations, for which the Ca/Sr and $^{87}Sr/^{86}Sr$ ratios are estimated from acid leaches of soils, can be ruled out as a major Ca source to current foliage. Within sites, the $^{87}Sr/^{86}Sr$ ratio of the soil exchange pool in the Oa horizon and in the 0-10 cm and 10-20 cm increments of the mineral soil are similar to the Oie horizon and foliar values, suggesting a common source of Sr in all of the actively cycling pools, but providing no help in distinguishing among them as sources to foliage. The Ca/Sr ratio in the soil exchange pool, however, decreases significantly with depth, and based on this variation, the exchange pool below the forest floor (Oie + Oa) can be excluded

as a major Ca source to the current foliage. This study confirms that internal recycling of Ca between litter, organic soil horizons and vegetation dominate annual uptake of Ca in northern hardwood ecosystems. Refinement of our understanding of Ca and Sr uptake and allocation in trees allows improvement in the use of Ca/Sr and $^{87}Sr/^{86}Sr$ ratios to trace Ca sources to plants.