Geophysical Research Abstracts
Vol. 19, EGU2017-18661, 2017
EGU General Assembly 2017

Calcium isotope systematics in small upland catchments affected by spruce dieback in the period of extreme acid rain (1970-1990)

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Recently, new isotope tools have become available to study the behavior of nutrients in stressed ecosystems. In this study, we focus on changes in the abundance ratio of calcium (Ca) isotopes accompanying biogeochemical processes in small forested catchments. We monitored del44Ca values in ecosystem pools and fluxes in four upland sites situated in the Czech Republic, Central Europe. A heavily acidified site in the Eagle Mts. (northern Czech Republic) experienced 13 times higher atmospheric Ca inputs, compared to the other three sites, which were less affected by forest decline. Industrial dust was responsible for the elevated Ca input. Del44Ca values of individual poos/fluxes were used to identify Ca sources for the bioavailable Ca soil reservoir and for runoff. The bedrock of the study sites differed (leucogranite, orthogneiss vs. serpentinite and amphibolite). Across the sites, mean del44Ca values increased in the order: spruce bark < fine roots < needles < soil < bedrock < canopy throughfall < open-area precipitation < runoff < soil water. Plant preferentially took up isotopically light Ca, while residual isotopically heavy Ca was sorbed to soil particles or exported via runoff. Even at sites with a low del44Ca values of bedrock, runoff had a high del44Ca value. At the base-poor site, most runoff came from atmospheric deposition and residual Ca following plant uptake. It appeared that bedrock weathering did not supply enough Ca to replenish the bioavailable Ca pool in the soil. Currently, we are analyzing Ca isotope composition of individual rock-forming minerals to better assess the effect of different weathering rates of minerals with low/high radiogenic 40Ca contents on runoff del44Ca.