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A 100 years retrospective of atmosphere and vegetation controlled chemical and isotopical evolution of a soil in a forested silicate catchment. Evidence from Sr, Nd, Pb and Ca isotopes in tree rings. (Strengbach case; Vosges mountains, France)

Peter Stille (1), Anne-Désirée Schmitt (2), Marc Steinmann (2), Eric Lucot (2), Florence Guéguen (1), Florian Cobert (1), Laure Brioschi (2), Marie-Claire Pierret (1), and François Chabaux (1)

(1) LHyGeS-UMR7517, EOST, Université de Strasbourg, INSU/CNRS, France (pstille@unistra.fr), (2) UMR 6249 Chrono-environnement, Université de Franche-Comté, F-25030 Besançon, France

The neutralization of acid atmospheric pollutant depositions on ecologically sensible ecosystems is controlled by chemical weathering processes of rock and mineral phases and by ion exchange processes in the soil which finally cause cation depletion in the uppermost soil compartments. This might be harmful for such ecosystems since some of them are necessary for the growth of vegetation. The export of these elements is partly interrupted due to their uptake by the plants root system. Here we show with help of Sr and Nd isotope determinations on tree growth rings of Picea abies that acidification of the soils and their depletion in nutrient basic cations like Ca started at least some 100 years ago ; as a consequence the importance of soil minerals as Ca source for vegetation successively diminished whereas the atmosphere became more and more an important source of base cations as indicated by the tree rings isotope ratios approaching todays atmospheric Sr and Nd isotopic signatures. However, the Ca depletion of the soil with time and the herewith induced stress for the tree did neither allow to recognize a physiology related Ca isotopic fractionation nor a source dependent change of the Ca isotopic composition as it has been observed in stemwood for the Sr and Nd isotope systems. The annual growth rings, however, are not reliable and suitable archives of past Pb pollution because they carry mixed isotopic signatures due to root uptake of geogenic Pb and anthropogenic Pb with different origins which has been accumulated in the uppermost part (40 cm) of the soil system at least during the past 200 years.