Absorption and fractionation of Rare Earth Elements (REE) by plants

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Rare Earth Elements (REE) are increasingly used by man (electronics industry, medicine, agriculture) and therefore considered as emerging pollutants. The present study documents REE mobility in non-polluted natural soil-plant systems in order to characterize their environmental availability for future anthropogenic pollution.

The study is based on a field approach in non-polluted natural sites with contrasting geological environments (limestone, granite and carbonatite) and highly variable REE contents. The data show that REE uptake by plants is not primarily controlled by the plant itself, but depends on the concentration and the speciation in the soil and the adsorbed soil water pool. REE uptake by plant roots are linked with those of Fe. Roots absorb preferentially the light REE (Fig. 1). Before translocation, REE are retained by the Casparian strip leading to much lower concentrations in the aerial parts. The transport of the REE within the xylem is associated with the general nutrient flux.

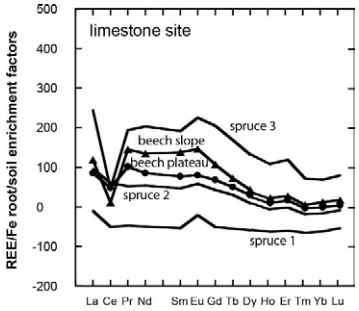

Figure 1: Soil-normalized REE/Fe ratios of plant roots ($[REE/Fe]_{root}/[REE/Fe]_{soil}*100$) showing that roots absorb the LREE preferentially with respect to Fe. Figure from [1].

[1] Brioschi *et al*. (2012) *Plant Soil*, DOI 10.1007/s11104-012-1407-0

Late Devonian "Kellwasser-Event" A global mass-extinction equivalent to the Precambrian-Cambrian boundary interval?

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The Late Devonian Kellwasser Event characterizes a significant epoch in the evolution of the Palaeozoic ecosphere and hosts one of the five major global mass-extinction events in Earth history. During this period massive continental renovations forced seawater level changes and climate instabilities thus provoking biogeochemical perturbations of the oceans likely comparable to the Precambrian-Cambrian evolution events. Culminating in the extinction of up to 60% of the pelagic biosphere the Kellwasser period is characterized by the deposition of two black shale successions, the so-called Kellwasser horizons (e.g. Germany, France, USA). Well preserved Devonian strata crop out in sections around the Kellwassertal in the central German Harz Mountains. However, geochemical data especially sedimentary bulk nitrogen isotope values from these rock sections are rare.

We determined $\delta^{13}C_{carb}$, $\delta^{13}C_{org}$ and $\delta^{15}N$ isotope values from an outcrop near Goslar including the basal cephalopod limestone, the lower and upper Kellwasser horizons and the overlying lower Famennian limestones. The section represents a carbonate-siliciclastic setting in a submarine rise environment permanently connected to the ocean but influenced by multiple trans- and regression events. $\delta^{15}N$ isotope data from the Kellwasser horizons reveal two major negative excursions, one shift down to -1.2‰, the latter -1.7‰. Two positive co-occuring $\delta^{13}C_{carb}$ and $\delta^{13}C_{org}$ excursions represent the global Kellwasser carbon isotope signal as already reported in other upper Devonian sections worldwide.

Our data represent trustful markers for the marine palaeo-oxygenation state and nutrient availability suggesting that biogeochemical events during the Frasnian-Famennian interval can roughly be compared to the Precambrian-Cambrian boundary interval and may record phases of photic zone anoxia. Scenarios like the stepwise upper Devonian mass-extinction of biota associated with marine transgressive events and negative $\delta^{15}N$ excursions can be paralleled to the Precambrian-Cambrian event recorded in sections e.g. of South China and Kazakhstan thus enabling new approaches of interpretation.

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