Absorption and fractionation of REE by vegetation: A comparative field study on plants grown on granite, carbonate, and carbonatite

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The Rare Earth Elements (REE) are extensively used to trace weathering and erosion of the continents. A recent study has shown that the uptake of REE by vegetation is comparable to export by surface runoff. Furthermore the REE patterns of surface runoff partly were shown to reflect exchanges with vegetation [1]. Therefore, the scope of the present study is a better understanding of the REE absorption and fractionation by plants in order to characterize their role in the exogenic REE cycle.

The natural REE cycle is progressively disturbed by anthropogenic REE, because the utilization of REE as additive in agriculture, electronic industry, and medicine has grown exponentially during the last 15 years [2]. First occurrences of anthropogenic REE in ecosystems have already been reported [3 and ref. included], but little is known about the pathways of anthropogenic REE in the environment and their ecotoxicological impact. The present study will also contribute to a better understanding of the transfers of anthropogenic REE in the environment.

We have chosen a comparative field approach on three contrasting field sites under temperate continental climate (acid brown soils on granite, calcareous brown soils on limestone, leached brown soils on carbonatite) in order to examine the transfer and the mass balance of the REE within the bedrock-soil-vegetation system. Our preliminary results show that soil and vegetation mainly reflect the REE pattern of the bedrock, with, however, some significant modifications. We found that vegetation is enriched in the light REE with respect to soil water, and that concentrations are highest in the roots, followed by leafs, and trunk. The transfer of the REE from soil to vegetation is mainly controlled by soil pH, and the oxide and organic matter content of the soil. We have furthermore determined the stock of REE in the vegetation cover and compare it with the soil reservoir.

[1] Stille *et al.* (2006) *GCA* **70** (13), 3217-3230. [2] Haxel *et al.* (2002) USGS Fact Sheet 087-02. [3] Kulaksiz & Bau (2007) *EPSL* **260**, 361-371.

The succession of primary producers in Proterozoic oceans

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99.9% of biomass in the oceans is remineralised back to CO_2. However, a small fraction of dead organic carbon becomes permanently buried in sediments, ultimately controlling atmospheric O2 levels. A major factor contributing to carbon burial is the type of organic matter produced by the dominant photosynthetic organisms. For instance, the emergence of land plants led to the formation of coal deposits and consequently increased atmospheric O_2 levels in the Carboniferous. In the Proterozoic (2,500 – 542 Ma), shifts between regimes of different primary producers may have had similarly dramatic effects on the atmosphere and carbon cycle. For example, most cyanobacteria produce high proportions of digestible carbohydrates, whereas algae often contain resistant cell wall material with a high chance of burial [1]. To determine if transitions from cyanobacteria dominated oceans to oceans dominated by successive groups of different algae were accompanied by carbon isotopic excursions and changes in redox state, we plotted published relative abundances of molecular fossils (biomarkers) against time from the late Archaean to the mid-Neoproterozoic (2,800 to 700 Ma). However, the distribution of biomarkers of primary producers displayed no age or depositional facies patterns nor were they distinguishable from any particular period in the Phanerozoic. This distribution is in conflict with the gradual and slow appearance of major eukaryotic clades in the body fossil record.

The conflict between the records of micro- and molecular fossils may, in principle, have a biological or preservational explanation. However, using new methodologies that eliminate traces of younger contaminants, we show that a great proportion of the Precambrian biomarker record is compromised by anthropogenic petroleum products [2, 3]. Our reappraisal of biomarkers between 2,800 and 542 Ma shows that biomarkers of eukaryotic algae are, in general, rarely detected in the Precambrian and, if present, very distinct from the Phanerozoic. Although the record of sedimentary sequences with demonstrably indigenous biomarkers is still exceedingly patchy, an evolutionary pattern emerges that is broadly consistent with microfossil evidence.

[1] Logan *et al.* (1997) *Geochim. Cosmochim. Acta* **61**, 5391-5409. [2] Brocks *et al.* (2008) *Geochim. Cosmochim. Acta* **72**, 871-888. [3] Rasmussen *et al.* (2008) *Nature* **455**, 1101-1104.