Speciation and fractionation of rare earth elements in a lateritic profile from southern China: Identification of the carriers of Ce anomalies

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The mobilization of rare earth elements (REE) during weathering has been well documented. However, there are still few studies of REE speciation in weathering profiles. Furthermore, ambiguities remain concerning the carriers of Ce anomalies (Braun et al., 1990; Taunton et al., 2000). This study is to investigate the form and distribution of REE during weathering and identify the carriers of Ce anomalies.

Methods

A sequential extraction procedure has been carried out on weathered samples from a 25m thick granitic profile in South China. Five phases were selected for extraction: adsorbed-exchangeable REE, bound to carbonates, bound to iron and manganese oxides; bound to organics, and residual. REE were determined with High Resolution ICP-MS.

Results and Discussion

Bulk rock chemical data show that the REE have been fractionated during weathering. LREE are leached from the top zones and extremely enriched in the middle of the profile. While from the bottom to top of the profile HREE become more and more depleted, and LREE/HREE ratios obviously increase. Ce is fractionated from the other LREE: strong positive Ce anomalies are presented in the oxidized soil zone.

In this profile the most important carrier of REE is exchangeable fraction. About 40-90% of the total REE is exchangeable, and even up to 95% at 10-11 m. 10-30% of REE is bound to Fe-Mn oxides, and in the oxidized soil zone up to 35%. Similarly, in the upper zone 10-25% of REE is linked to organics, and even up to 30% in the humus-layer.

In the upper soil zone the normalized REE patterns of the exchangeable fraction present positive Ce anomalies and LREE enrichment relative to fresh rock, and more than 50% of Ce is exchangeable in the clayey zone, implying clay is an important carrier of Ce anomalies. The REE patterns in Fe-Mn oxides show strong positive Ce anomalies, and in the oxidized soil zone up to 70% of total Ce is bound to Fe-Mn oxides. Similarly, the normalized REE patterns in organic fractions present strong positive Ce anomalies, and in the humus-layer Ce/Ce^{*} is up to 100, which suggests that organic matter plays an important role in the retention of Ce.

It is concluded that secondary clay minerals, Fe-Mn oxides and organic material act as main traps for REE in the soil, and they are also important carriers of Ce anomalies.

References

Braun J.J. et al., (1990), *GCA* 54, 781-795.
Taunton A.E. et al., (2000), *Chem. Geol.* 169, 371-382.

RNA as a biomarker: Isolation of small-subunit ribosomal RNA for stable isotopic characterization

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Small-subunit ribosomal RNA (SSU rRNA) is a good candidate biomarker. It is found in bacteria, archaea, and eukaryotes; is quickly degraded extracellularly, so that rRNA extracted from a sample likely derives from active populations; and includes both conserved and variable regions, allowing the design of capture probes at various phylogenetic levels. rRNA sequences from uncultured or newly isolated species can be classified by comparison with the public database. We have developed a method for isolation of specific classes of rRNAs from mixtures of total RNA, employing biotin-labeled oligonucleotide probes and streptavidin-coated paramagnetic beads (Fig. 1).

We have also shown that for *Escherichia coli* grown on LB, M9 glucose or M9 acetate, the stable carbon isotope composition of total RNA and SSU rRNA reflect that of whole cells and of the growth substrate (Fig. 2).

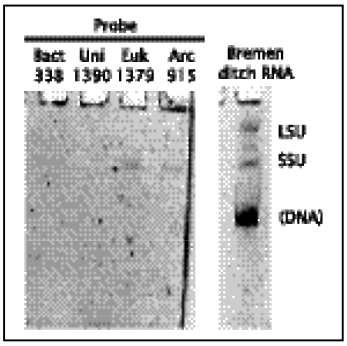

Figure 1: Separation of specific rRNAs from environmental samples. RNA isolated from ~250 mg of Bremen town ditch sediment was hybridized with the probes shown. The rightmost lane contains total RNA isolated from ~5 mg sediment.

SSU rRNA is therefore a promising biomarker for following carbon (and potentially nitrogen) flow in microbial populations, especially where substrates have strong isotopic signatures.

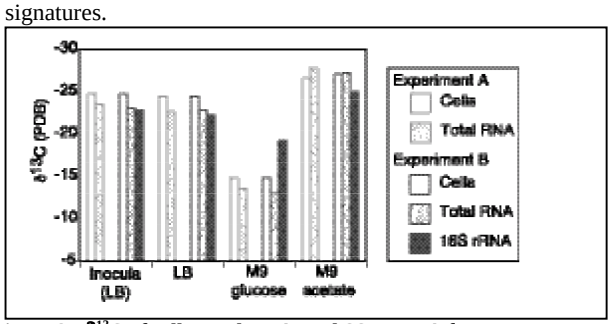

Figure 2: $\delta^{13}C$ of cells, total RNA, and SSU rRNA from overnight *E. coli* inocula and cultures.

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