

Rare Earth Elements in the Amazon Basin: Encontro das Aguas

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Rare earth elements (REE) abundance patterns of rivers water dissolved, colloidal and suspended material should provide valuable information both for the aquatic cycle of the REE and the knowledge of the weathering processes occurring on the continental crust. Moreover, REE are elements which are sensitive to major geochemical processes occurring in waters such as: surface complexation, redox variation, organic matter complexation. Their properties should help for a better understanding of the above mentioned processes in natural systems. Size fractionation by ultrafiltration coupled with the complexation capacity measurements is a powerful tool to gain knowledge about trace element speciation in aquatic systems. Here we report the distribution of REE. The distribution and the degree of association of major and REE with the discrete size fractions are presented. This study focuses on one of the most important zone for the amazon basin, the "encontro das aguas" area where the two major rivers of the basin, the Rio Solimoes and the Rio Negro meet.

Samples were taken in Brazil 1997 during a cruise on the Rio Negro and on the Amazon river from Manaus to Obidos devoted to the study of the mixing zone. Water samples at various depth and distance from the mixing were taken and treated on board with sequential cross flow ultrafiltration. All samples were treated in the same way: 2 litres of water were filtered using clean ultrafiltration membranes with the molecular cutoffs of 0.2 μ m and 5kD. All membranes were cleaned in the lab with 10 litres of MQ water. In the field the first 0.25 litres were systematically discarded to prevent sample contamination during the filtration. Total C and metal ion (Na, K, Ca, Mg, Al, Fe...) concentrations were measured in each concentrated fraction and as well as in the permeate. Metal ions were determined by ICP AES and GFAAS. Mass balance calculations indicate a good recovery of carbon and metal ions (>80%). REE concentrations were measured with ICP-MS. Detection limits are in the range of a few tenth of ppt.

In the present volume, we report data on bulk unfiltered samples, and filtered fractions P1 and P2 corresponding to 0.2 μ m and 5000D cut-off membranes, respectively. The first striking result is that the Rio Solimoes has bulk water REE concentrations higher than the Rio Negro. For the smaller fractions this trend is reversed since the REE concentrations in the Rio Negro are always higher. The same trend is observed for mixed samples which have the highest contribution of the Rio Negro end member. The distribution of the REE among the different size fractions is a direct consequence of such a pattern. For the Rio Negro 50 to 30 % of the REE are concentrated in the particulate fraction (>0.2 μ m). The major part of the REE (50-60%) is therefore found in the colloidal fraction (0.2 μ m >> 5000D) while only 0 to 10% remains in the so called dissolved fraction (<5000D). For the Solimoes a totally different distribution is observed. More than 95% of the REE are located in the particulate fraction. Only a minor amount is found in the colloidal fraction and the dissolved fraction. For samples corresponding to various proportions of the end members all intermediate compositions are found.

When we normalised the first permeate (<0.2 μ) to the unfiltered sample a general enrichment for the heavy REE is observed in the REE patterns. Also a strong Eu anomaly is seen on the different REE pattern diagrams irrespective of the proportion of the mixing. When the second permeate (<5000D) is normalised to the first (<0.2 μ) the heavy REE enrichment can still be distinguished in the REE pattern diagrams. However the enrichment is much less pronounced than in the first normalisation. Again in this pattern a Eu anomaly is observed. The more classical normalisation to the shale gives very flat REE pattern for most of the water samples fractions. Owing to the knowledge of the mixing proportions of the two end members that are well characterised we can calculate the theoretical composition of the different water samples corresponding to different mixing proportions and compare it to the actually measured concentration. The geochemical implications of this calculation will be discussed in the extended paper.

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