Colloidal transport of Rare Earth Elements in rivers: Impact of geological setting and human activity

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Recent human activities (e.g. new technologies, medical imagery) has led to higher input of Rare Earth Elements (REE) into the aquatic environment.Various anthropogenic anomalies are now observed (La and Gd mainly). If anthropogenic Gd is mainly associated to organic ligands, colloidal forms of REE have been demonstraded to contribute greatly in their total concentrations (in rivers), especially during flood events when the river discharge increases. However, few is known about the nature of colloids (e.g. humic substances, metal oxides or clay minerals) involved in REE transport. Hence, our objectives were (i) to identify the colloidal pools of REE in temperate rivers, so as to better understand their speciation and (ii) to quantify the effects of different geological settings, human activities and lad use on REE levels and speciation.

Nine river basins (8 from Luxembourg and the Rhine River at Lobith in The Netherlands), presenting contrasted physiographic characteristics (geology, size, land use, human activity) were sampled during low and high river flow conditions. Samples were filtered and ultrafiltred to separate the particulate (>1000 nm) from the colloidal (1000 nm-10 kDa) and the “trully” dissolved (<10 kDa) REE fractions. REE were analyzed using ICP-MS in all size fractions. Additionally, the colloidal REE fraction with a size <220 nm was characterized by using Asymetric Flow-Field Flow (A4F) coupled online to a UV-DAD and HR-ICP-MS allowing for a continuous size separation and online detection of element concentrations.

The higher REE concentrations are found in the fractions between 10 kDa and 220 nm. A4F results highlighted three pools of REE: humic substances associated with Ca and Fe (1-5 nm), Al- and Fe-(hydr)oxides (20-40 nm), and clay mineral nanoparticles (100-150 nm). The presence of these pools appears to be influenced by by geology and land use. Our results highlight the importance of considering different colloids in the transport of REE in rivers and this can help to better understand REE bioavailability and their possible impact in the aquatic environment.