Bacterial cells can biosorb and accelerate the transport of heavy metals mixtures in soils

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Recent field observations have demonstrated that supposedly poorly mobile metals can be detected at long distances from their source, highlighting the importance of poorly predicted transport processes. The fast mobilisation of metals by the colloidal and mobile fraction of soils and in particular biotic colloids (bacteria, algae, fungi, virus, etc.), is now identified as an important secondary transport process that can lead, under specifc conditions, to accelerated and potentially dominant pollutant transfer towards aquifers. In order to better understand the role of the bacterial compartment of soils to metal leaching, we conducted a coupled study under static and dynamic conditions. Firstly we evaluated Zn and Cd metal biosorption onto active or inactive Gram negative bacteria (*Escherichia coli* and *Cupriavidus metallidurans* CH34) by characterizing the sub-cellular distribution of the metals through a cell disruption approach. The quantification of Zn and Cd in extracellular, membrane and cytoplasm compartments of the cells permitted to show that metals are unequally distributed between the three cell compartments and also between the two bacteria. Surprizingly, metals internalization appeared to be the dominant accumulation process of metals (high cytoplasm contents). The physiological state of the cells was also shown to be important in metal management by the bacteria, since metal accumulation in active cells was reduced due to enhanced efflux and/or EPS production mechanisms. These results suggest bacteria can internalize important amounts of heavy metals and also that adsorption onto cell surface is only a first step in metal management by bacteria. The so-determined thermo-dynamic reactivity constants were used to fit metal breakthrough curves performed in natural sand columns. The transport experiments of bacterial cells, metals or mixtures of bacteria and/or metals performed in the second part of the study, demonstrated that bacteria are able to accelerate the *in situ* mobilization of Cd and Zn retained in natural sand columns. This transport process was shown to be dominant upon aqueous transport and was correctly fitted using a combined transfer and geochemical modeling approach. Altogether, these results showed that, under specific conditions, heavy metal transport by bacterial cells can dominate aqueous transport processes in soils.

Silicon stable isotope constraints on the global oceanic Si cycle

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The global oceanic distribution of nutrients such as silicon (Si) governs the distribution and magnitude of primary productivity in the sea, and thus the strength of the ocean's biological carbon pump. These nutrient distributions are the combined result of biological and physical processes that interact over a range of temporal and spatial scales. Information on the stable isotope composition of dissolved nutrients can be employed to deconvolve the processes contributing to the observed oceanic tracer field, potentially allowing the identification of nutrient sources and/or the relevant biological–physical cycling processes.

We will present a dataset of the stable Si isotope composition of dissolved silicon (expressed as δ^{30}Si) from three major oceanic regions: the Atlantic, the Southern Ocean and the South Pacific, including samples collected as part of the GEOTRACES programme. This high-precision dataset has been produced by a single laboratory, allowing a more robust assessment of intra- and inter-basin gradients than has been previously possible.

The coherence of the δ^{30}Si distribution in the deep Atlantic is a testament to the strength of δ^{30}Si as a tracer of the modern oceanic Si cycle. Values of δ^{30}Si vary systematically with Si concentration, from +1.7‰ and higher in the Si-poor deep subpolar North Atlantic to values of +1.2‰ in the deep South Atlantic, associated with the mixing of water masses of Nordic and North Atlantic origin with Si-rich bottom waters from the Southern Ocean. The North Atlantic most likely owes its high-δ^{30}Si signature to the input of ^{30}Si-enriched silicic acid through the upper return path of the meridional overturning circulation (MOC), indicating that the basin-scale δ^{30}Si gradient in the deep Atlantic is dominantly controlled by the interaction of biological Si utilisation with subsurface watermass formation in the Southern Ocean, and subsequent Si transport by the MOC.

In our presentation, we will extend our analysis of oceanic δ^{30}Si in the MOC context to the global ocean, including the interpretation of our dataset in the framework of geochemical box models of the ocean.