Heterogeneous distribution of Zn stable isotopes in mice

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Zinc is required for the function of more than 300 enzymes involved in many metabolic pathways, and is a vital micronutrient for living organisms. To investigate if Zn isotopes could be used to better understand metal homeostasis, as well as a biomarker for diseases, we assessed the distribution of natural Zn isotopes in various mouse tissues. We found that, with respect to Zn isotopes, most mouse organs are isotopically distinct and that the total range of variation within one mouse encompasses the variations observed in the Earth's crust. Therefore, biological activity must have a major impact on the distribution of Zn isotopes in inorganic materials. The most striking aspect of the data is that red blood cells and bones are enriched by ~0.5 per mil in ^{66}Zn relative to ^{64}Zn when compared to serum, and up to ~1 per mil when compared to the brain and liver. This fractionation is well explained by the equilibrium distribution of isotopes between different bonding environments of Zn in different organs. Differences in gender and genetic background did not appear to affect the isotopic distribution of Zn. Together, these results suggest that potential use of Zn isotopes as a tracer for dietary Zn, and for detecting disturbances in Zn metabolism due to pathological conditions.

Cd mobility in anoxic Fe-mineral-rich environments – potential use of Fe(III)-reducing bacteria for soil remediation

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Agricultural soils worldwide are increasingly burdened with heavy metals such as Cd from industrial sources and impure fertilizers. Metal contaminants potentially enter the food chain via plant uptake from soil and may affect human and environmental health negatively. New remediation approaches are needed to diminish soil metal contents, but in order to apply them it is necessary to understand how soil microbes and minerals interact with these toxic metals.

Here, we show that microbial Fe(III) reduction leads to Cd immobilization in Cd-bearing anoxic soils. To understand how microbial Fe(III) reduction influences Cd mobility, we isolated a new Cd-tolerant, Fe(III)-reducing *Geobacter sp*. strain Cd1 from a heavily Cd-contaminated soil in Germany. In lab experiments, this *Geobacter* strain first mobilized Cd from Cd-loaded Fe(III) (oxyhydr)oxides followed by precipitation of Cd-bearing mineral phases. Using Mössbauer spectroscopy and Scanning Electron Microscopy, the original and newly formed Cd-containing Fe(II) and Fe(III) mineral phases, including Cd-Fe-carbonates, Fe-phosphates and Fe-(oxyhydr)oxides, were identified and characterized. Using Energy Dispersive X-ray spectroscopy and Synchrotron-based Scanning Transmission X-ray Microscopy, Cd was mapped in the Fe(II) mineral aggregates formed during microbial Fe(III) reduction.

Microbial Fe(III) reduction mobilizes Cd prior to precipitation of the Cd as Cd-bearing mineral phases. On the one hand, the mobilized Cd could potentially be taken up by phytoremediating plants, resulting in a net removal of Cd from contaminated sites. On the other hand, Cd precipitation could immobilize Cd more strongly and reduce Cd bioavailability in the environment, causing less toxic effects to crops and soil microbiota. However, the stability and therefore bioavailability of these newly-formed Fe-Cd mineral phases needs to be assessed thoroughly. Whether phytoremediation or immobilization of Cd in a mineral with reduced Cd bioavailability are feasible mechanisms to reduce the toxic effects of Cd in the environment still remains to be determined.

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