δ^{66} Zn as a tracer of the zinc biogeochemical cycle

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Zinc is an essential element for plants but excessive uptake can lead to (phyto)toxicity and contamination of the foodweb. Mobility and bioavailability depend on zinc speciation in solid and liquid phases, and exchange processes. Zinc isotopic ratios are a new and sensitive tool as biogeochemical cycle tracers.

The substrates were two soils contaminated by aerial fallouts - a clayey calcareous soil (CaS) and a a loamy shale-derived soil (ShS) - and a gravelly slag dump (SD) from mettalurgical industry. Fine earth fractions (fef, <2mm) were obtained by dry sieving. The soil solutions were collected *in situ* through zero-tension lysimeters inserted under organic horizon (O) and organo-mineral horizon (Ah). Shoots of plants growing on substrates were also sampled. After zinc purification by a novel chromatographic method performed on micro-columns (Zn blanks$\leq$2ng), the values of the Zn isotopic ratio (δ^{66}Zn) were measured on a Nu Plasma MC-ICP-MS.

In agreement with the known effect of industrial Zn extraction process, fef determinations showed that SD was richer in heavy isotopes than soils contaminated by aerial fallout. Throughout the soil profiles, systematic enrichment in light Zn isotopes was recorded from Ah horizons (0.18-0.34‰) to O horizons (0.09-0.18‰). In addition, soil solutions showed stronger light Zn isotope enrichment, especially solutions leached from O horizons, with a fractionation magnitude up to 0.41‰. Plant uptake involved mainly heavy Zn isotopes in plants and, therefore, was associated with decrease of heavy Zn isotopes in soil solutions. Finally, isotopic ratio of bedrocks influenced δ^{66}Zn in fef of deep soil horizon. In CaS, there was a transfer of heavy Zn isotopes from bedrock to deepest soil horizon; whereas in ShS, there was transfer of light Zn isotopes.

In summary, Zn isotopic fractionation is highly sensitive and helpful to study the mobility of zinc in the soil-plant cycle.

Geomicrobiology of microbialites from the Alchichica alkaline lake

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Microbialites are organosedimentary structures resulting from the activity of microbes. Although they dominate the Precambrian geological record, the abiotic and biological processes leading to their formation and thus the exact information that can be retrieved from them are still poorly understood. In this study, we used a combination of molecular biology and mineralogy analyses to study modern microbialites from the Alchichica lake at different spatial scales. Alchichica is an alkaline (pH ~8.9) crater lake located at high altitude (2,300 m above sea level) in the Puebla State, Mexico, that harbours an extensive collection of living microbialites. XRD analyses on bulk samples showed that they are formed of hydromagnesite, $Mg_5(CO_3)_4(OH)_2{\cdot}4(H_2O)$ and aragonite consistently with precipitation in a Mg-rich, alkaline solution. The textures of these mineral phases, and their relationships with the distribution of the microbes were assessed down to the nm-scale using SEM, FIB milling, TEM and synchrotron-based X-ray microscopy (STXM). In parallel, we explored the microbial diversity of a subset of samples by amplifying, cloning and sequencing 16S rDNA genes from microbialite DNA, revealing a large diversity of cyanobacteria but also various other groups of Bacteria. Finally, some samples were incubated in laboratory aquaria. The growth of cultured microbial mats was monitored using the same analytical approaches. Moreover, we used confocal laser scanning microscopy to better link the results provided by the molecular biology and the mineralogy approaches. This ongoing but comprehensive analysis of the Alchichica microbialites will provide a better picture of the microbial-mineral interplay in modern microbialites from an alkaline lake. The implications for the decryption of ancient microbialites will be discussed.