

A new methodology to determine trace selenium speciation in soils

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Analytical methodology development

For date, there is no procedure to determine Se speciation in soil containing native Se trace. We propose a methodology based on single selective extraction followed by liquid chromatography-inductively coupled plasma mass spectrometry detection. Conservation of the original Se speciation during extraction was checked for the seven tested extractants. Total Se was quantified in extracts and solid phases whereas Se speciation was determined in extracts.

Results and discussion

Se species stability was confirmed for all extractants excepted for nitric and citric acids. Highest efficiencies (58%) were obtained with NaOH (Fig. 1), generally used to dissolve organic solid phases. Phosphate buffers ($\text{KH}_2\text{PO}_4/\text{K}_2\text{HPO}_4$) showed similar results ($\approx 20\%$) whatever the pH. They are used to access Se bounded to mineral phases. Water and CaCl_2 (5.10^{-4}mol/L) efficiencies were very low ($\approx 1\%$). Therefore, three species (SeIV, SeVI, MeSeOOH) were observed in these extracts, whereas SeIV was the single extracted Se species in phosphate buffers and NaOH. Moreover, water and CaCl_2 represent the most mobile and bioavailable Se.

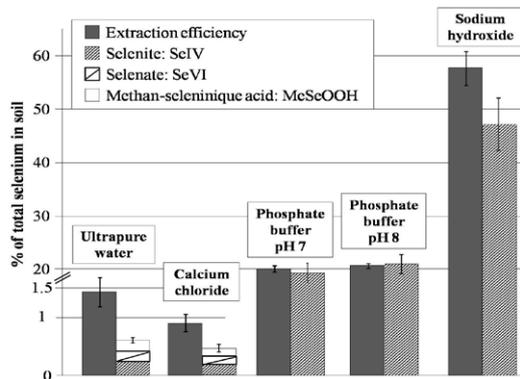


Figure 1: Extraction efficiencies and Se speciation in extracts

These five extractants are thus relevant for environmental studies of Se speciation in soils as they allow assessing Se species and related mobility and bio-availability.

Retention of biogeochemical signatures by iron oxyhydroxide minerals in deep-sea deposits

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Marine hydrothermal circulation is a fundamental process in which heat and chemical species are exchanged between seawater and ocean crust; this process drives biogeochemical cycling of iron (Fe) in deep marine settings. Deposition of Fe-bearing minerals, especially Fe oxyhydroxides, from hydrothermal fluids is a globally distributed phenomenon. The mineralogy of the deposits is a fundamental property of the biogeochemical setting, and may record physical-chemical-biological conditions present at the time of mineral formation. However, the structure or continuum of structures that compose the Fe oxyhydroxides, including ferrihydrite, is a scientific controversy in itself. These minerals are difficult to describe because of nanometer particle dimensions and structural variability. Mineral precipitation within microbial biofilms or in the presence of strongly adsorbing chemical species (ligands) is known to create structural complexity. The mineralogy of Fe oxyhydroxides precipitated from submarine hydrothermal fluids, in the presence of abundant inorganic ligands and microbial life, remain elusive even in active systems.

To address this knowledge gap a number of integrated biogeochemical investigations of Fe speciation and mineralogy in deep marine systems are underway. From the mineralogy side, the research strategy is to focus on a suite of fundamental properties of Fe deposits that can be measured with confidence: short-range structural order and valence state; degree of structural defects relative to standard synthetic minerals; degree of particle interaction and aggregation; distribution of particle dimensions, and particle morphology. Then, through multi-disciplinary efforts, the mineralogy is interpreted in the context of geology, geochemistry, and biology.

The results from mineralogical studies conducted on Fe oxyhydroxides from East Pacific Rise 9°N, Loihi Seamount, and Juan de Fuca Ridge will be discussed; including, synchrotron radiation X-ray absorption spectroscopy, X-ray diffraction, and scanning transmission X-ray microscopy data. These studies provide insight into the structure and formation of Fe oxyhydroxide minerals in the deep-sea. The morphological and mineralogical signals that result provide a starting point from which progressively older and more extensively altered seafloor deposits may be examined, with the ultimate goal of improved interpretation of ancient microbial processes and associated biological signatures.