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Study of stable isotopes of sulfur in forest soils using MC ICP-MS – analytical challenges and solutions

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Sulfate impact to forest ecosystems is one major factor for the acid rain phenomenon causing export of base cations from soil and decrease of soil pH - both leading to forest dieback. Although regulations have been applied and sulfate immissions have decreased significantly, elevated amounts of sulfate can still be found in the soil. This is caused by sulfate reactions and transformation changes (adsorption and desorption, reduction and oxidation, uptake and mineralization of organic S-compounds) slowing down its export from the soil. Separating of soil samples into different sulfur pools (soluble and adsorbed sulfate and organic sulfur compounds), together with the analysis of stable isotopes of sulfur (³⁴S/³²S) has the potential to trace back sulfate transformation changes and/or help to identify sulfur sources additional to atmospheric sulfate deposition (e.g. weathering of sulfur bearing minerals).

Soluble- and adsorbed sulfate extraction procedure was optimized for ICP-MS detection and validated using RTS sulfur reference material.

³⁴S/³²S isotopic ratios measurement by multi collector ICP-MS meets challenges: spectral and non-spectral interferences, instrumental isotopic fractionation and background sulfur concentrations. To overcome these challenges, following steps were applied: a membrane separation of sulfate to eliminate non-spectral interferences, external calibration of isotope amount ratios to correct for instrumental isotopic fractionation and adaptation of sulfur concentration in samples to enhance the signal to blank ratio.

The optimized method was applied to analyze soil samples from the Vienna Woods and Kobernauberwald. The sulfur mass fraction in upper soil layers is significantly higher than in 50 cm depth. The ³⁴S/³²S isotope ratio is depleted in upper soil layers indicating microbial sulfur treatment as soil microfauna preferably metabolizes the lighter sulfur isotope ³²S.