



Isotope Analysis for Source Exploration and Degradation Assessment of Sulfate

Sulfate is among the major geogenic component in groundwater. Additional anthropogenic inputs come from agricultural fertilization and from the deposition of dust and sulfur oxides. Elevated concentrations can also be a result of nitrate pollution caused by denitrification including the chemolithotrophic oxidation of pyrites. Based on sulfur and oxygen isotope ratios ($^{34}\text{S}/^{32}\text{S}$ as $\delta^{34}\text{S}$, $^{18}\text{O}/^{16}\text{O}$ as $\delta^{18}\text{O}$), anthropogenic, terrestrial, marine and atmospheric sulfate sources can be differentiated.

Under anoxic conditions, microorganisms can use sulfate as an electron acceptor. During microbial sulfate reduction, the heavy sulfur and oxygen isotopes (^{34}S , ^{18}O) accumulate in residual sulfate leading to more positive $\delta^{34}\text{S}$ and $\delta^{18}\text{O}$ values of sulfate. This change can be used to evaluate sulfate degradation.



Sampling



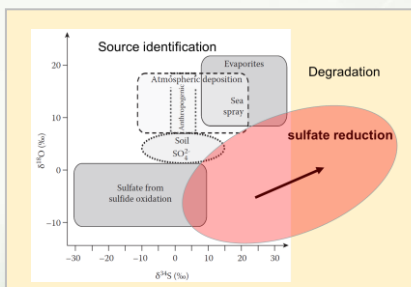
Preparation



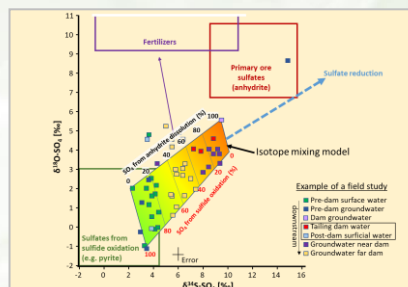
Analysis



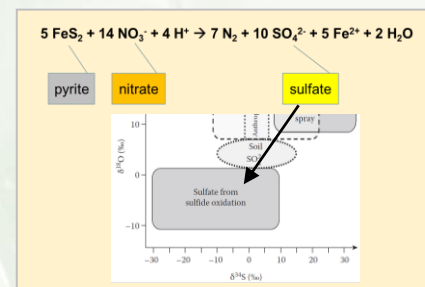
Expertise



Various sulfate sources in groundwater exhibit specific sulfur and oxygen isotope values ($\delta^{34}\text{S}$, $\delta^{18}\text{O}$). Increasingly positive $\delta^{34}\text{S}$ and $\delta^{18}\text{O}$ ratios provide evidence for sulfate degradation.



Based on sulfur and oxygen isotope ratios ($\delta^{34}\text{S}$, $\delta^{18}\text{O}$) of sulfate, it is possible to verify the inflow of acidic mining water into surface water and groundwater.



Pyrite can be oxidized to sulfate by chemolithotrophic denitrification. The resulting sulfur and oxygen isotope ratios ($\delta^{34}\text{S}$, $\delta^{18}\text{O}$) are particularly negative and indicate nitrate degradation.

Workflow

- We develop an investigation concept taking into account site-specific conditions.
- We provide sampling flasks and protocols.
- We carry out isotope analysis of sulfate.
- We interpret isotopic data to discriminate sulfate sources and evaluate degradation processes.

Costs

$^{34}\text{S}/^{32}\text{S}$, $^{18}\text{O}/^{16}\text{O}$: 175 – 240 € per sample
plus expertise

Benefit

Differentiation of sulfate sources
Detection and quantification of sulfate degradation
Indication of denitrification

Further reading

Wang H, Zhang Q (2019) Research advances in identifying sulfate contamination sources of water environment by using stable isotopes. Int. J. Environ. Res. Public Health 16: 1914.

Knöller K, Fauville A, Mayer B, Strauch G, Friese K, Veizer J (2004) Sulfur cycling in an acid mining lake and its vicinity Lusatia, Germany. Chem. Geol. 204: 303-323.

Zhang YC, Slomp CP, Broers HP, Bostick B, et al. (2012) Isotopic and microbiological signatures of pyrite-driven denitrification in a sandy aquifer. Chem. Geol. 300-301: 123-132.