What do noble gases in surface-water sediments tell us?

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The concentrations of atmospheric noble gases in water are determined by the physical conditions (air pressure, water temperature and salinity) prevailing during gas exchange with the atmosphere. After separation from the atmosphere, the atmospheric noble-gas concentrations in the water remain unchanged. They therefore reflect the physical conditions during the last contact of the water with the atmosphere. In addition, the accumulation of terrigenic or radiogenic noble-gas isotopes may reflect the mixing dynamics of a water body. These principles were used for palaeoenvironment reconstruction and for dating using noble-gas records in groundwater.

We extended the application noble-gas geochemistry to the pore water of unconsolidated sediments of lakes and oceans. This presentation provides an overview of the spectrum of existing and potential new applications of noble-gas geo-chemistry in this stratigraphically controlled environment.

In some sediments, dissolved noble gases are trapped in the sediment pore space. The vertical profiles of dissolved noble-gas concentrations in the pore water are therefore controlled by the stratigraphy of the sediment. Such noble-gas records can therefore serve as archives for the quantitative reconstruction of palaeoenvironmental conditions, such as the salinity and water level of lakes in the past.

In contrast, the noble-gas profiles may also be controlled by vertical diffusion within the sediment column. In these sediments, noble-gas isotopes are useful proxies to study the processes and dynamics of the transport of solutes and fluids in the sediment and their exchange between the sediment and the overlying water body. Also, dissolved noble gases in sediment pore water may prove to be useful in studying fundamental aspects of solute transport, such as isotope fractionation due to diffusion processes or the relative importance of diffusion and advection on the overall transport.

Also, noble gases are sensitive tracers for the dynamics of secondary gas exchange processes in the sediment. The noble-gas signature of sediment pore waters therefore allows analysis of the formation of non-atmospheric gases in the sediment (e.g. CH_4 or CO_2) and their release into the water body.

Characterising the Si isotope signatures of Si pools in soils using UV femtosecond LA-ICP-MS

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Soils play an important role in the global Si cycle, which directly influences the C cycle via silicate weathering and primary production of silica-secreting organisms in the oceans. All processes involving release or precipitation of Si at low temperatures are associated with significant mass-dependent stable isotope fractionation. In order to understand the Si cycle in soils, we have characterized the Si isotope composition of the principle Si pools in soils on both bulk materials and at high spatial resolution on the mineral scale. The method used was a UV femtosecond laser ablation system coupled to a MC-ICP-MS in Hannover, allowing measurement of δ^{30}Si with a precision of 0.2‰ (2SD). The following Si pools have been investigated: a) bulk soils after fusion to a glass bead in a vacuum strip heater; b) Si from soil solutions as dried Si-gel film after chromatographic separation of Si; c) the difference between bulk silicates including quartz and feldspar on the one hand and secondary clay minerals on the other hand on fractions of different grain sizes as pressed pellets; d) the Si isotope difference between primary silicates and clays in polished thin sections of undisturbed soil samples; e) the Si source to soils on all major silicate minerals on thin sections from bedrock fragments in the soil profiles.

Soil profiles developed on sandstone and paragneiss, respectively, in the Black Forest (Germany) were investigated. Bulk soils show no differences between different horizons and locations, and Si isotope compositions are close to those of primary minerals. For all soil horizons at both locations, primary minerals reveal a narrow range in δ^{30}Si value around -0.2‰. However, substantial internal silicate cycling has ocurred as clay minerals, show values around -0.5‰ with a greater variability. Probably adsorption processes enrich secondary minerals in light isotopes, while heavy Si is lost into solution (e.g. [1]).

[1] Ziegler *et al.* (2005) *GCA*.