

Noble gas isotope ratios as tracer for molecular diffusion in lake sediments

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Molecular diffusion is an important physical exchange mechanism for solutes in water, in particular for gases dissolved in the pore water of lacustrine sediments. Noble gases are inert and therefore these concentrations are only controlled by physical processes. Thus noble gases are ideal tracers for gas transfer processes in aquatic systems. Many studies assume molecular diffusion of noble gas isotopes in water to be mass dependent and described in terms of the reciprocal of the square root of the ratio of their atomic masses [1]. This assumption has not been experimentally verified for the isotopes of Ne, Ar, Kr and Xe.

Therefore a laboratory study was conducted determining whether diffusion through immobilized water caused a fractionation of the isotope ratios of Ne, Ar, Kr and Xe [3]. Whereas Ar isotopes were mass dependently fractionated, Ne isotopes - in agreement with the molecular dynamics model [2] - hardly showed any fractionation. According results for Kr and Xe are currently evaluated.

As a consequence of our laboratory result Ar isotopes were used to study the gas exchange and its dynamics in the sediment pore water of Lake Rotsee and Lake Lungern, two Swiss lakes characterised by methane bubbles formed in the sediment and frequently released via ebullition. In both lakes the ratio of Ar isotopes dissolved in the pore water was found to be fractionated relative to air saturated water indicating that diffusive exchange controls the gas partitioning between CH₄ bubbles and noble gases dissolved in the surrounding pore water.

[1] Graham T. (1833) *Philos. Mag.* **2**, 175–358. [2] Bourg et al. (2007) *Geochim. Cosmochim. Ac.* **71**, 5583-5589. [3] Tyroller et al. (2014) *Geochim. Cosmochim. Ac.* **136**, 60-66.