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Using noble gases in the pore water of ocean sediments to characterize CH_4 seepage off the coast of New Zealand

Yama Tomonaga (1), Matthias S. Brennwald (1), Rolf Kipfer (1,2,3)

(1) Eawag, Swiss Federal Institute of Aquatic Science and Technology, Water Resources and Drinking Water, Duebendorf, Switzerland (tomonaga@eawag.ch, +41 58 765 5365), (2) Institute of Biogeochemistry and Pollutant Dynamics, Swiss Federal Institute of Technology (ETH), Zurich, Switzerland, (3) Institute of Geochemistry and Petrology, Swiss Federal Institute of Technology (ETH), Zurich, Switzerland

Newly developed analytical techniques to determine the abundances of noble gases in sediment pore water [1, 5] allow noble-gas concentrations and isotope ratios to be measured easily and routinely in unconsolidated lacustrine sediments [6, 7]. We applied these techniques for the first time to ocean sediments to investigate an active cold methane seepage system located in the South Pacific off the coast of New Zealand using $^3\mathrm{He}/^4\mathrm{He}$ ratios determined in the sediment pore water.

Our results [8] show that more ^{3}He-rich fluids are released in the vicinity of the Pacific-Australian subduction zone than at the forearc stations located closer to the New Zealand coast. However, the $^3\mathrm{He}/^4\mathrm{He}$ isotope signature in the sediment column indicates that only a minor part of the He emanating from deeper strata originates from a (depleted) mantle source. Hence, most He in the pore water is produced locally by the radioactive decay of U and Th in the sediment minerals or in the underlying crustal rocks. Such an occurrence of isotopically heavy crustal He also suggests that the source of the largest fraction of methane is a near-surface geochemical reservoir. This finding is in line with a previous $\delta^{13}\mathrm{C}$ study in the water column which concluded that the emanating methane is most likely of biological origin and is formed in the upper few meters of the sediment column [2]. The prevalence of isotopically heavy He agrees well with the outcome of other previous studies on island arc systems [3, 4] which indicate that the forearc regions are characterized by crustal He emission, whereas the volcanic arc region is characterized by the presence of mantle He associated with rising magma.

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