

Transformation of iodide to organic iodine in soil-water system

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Iodine is an important trace element for human beings according to the following reason: (i) iodine deficiency is one of the world's most prevalent disease, (ii) radioactive iodine can be released by the use of nuclear energy. To predict iodine behavior in natural systems, speciation of iodine is essential because mobility of iodine is different among each species. In this study, we determined chemical forms of iodine in soil and pore water using X-ray absorption near edge structure (XANES) and high performance liquid chromatography (HPLC)-ICP-MS, respectively.

Materials and methods

Soil and pore water samples were collected at five depths: 0, 3, 6, 9, and 12 cm under flooded condition in Yoro area, Chiba, Japan. Brine water, which contained I⁻, was supplied from top of the soil column. Iodine concentration in soil samples were determined by alkaline extraction method [1]. Chemical forms of iodine in soil were determined by K-edge XANES (SPring-8, BL01B1) [2]. Iodine mapping of soil grain was obtained at beamline 37XU (SPring-8) by a micro-XRF technique. Iodide, iodate, and organic iodine in pore water were separately detected by HPLC-ICP-MS using anion exchange column and size exclusion column. Soil incubation experiments were performed using soil collected at 3 cm depth (soil : Milli-Q water = 1 : 1) under oxic and unoxic conditions.

Results and Discussion

Concentration of iodine in soil was highly correlated with that of organic carbon content. According to XANES and micro-XRF, iodine in soil exists as organic iodine at any depths. On the other hand, pore water collected at a 0–6 cm depth containing 50–60% of organic iodine bound to dissolved organic matter and the rest was I⁻. At a 9–12 cm depth, 98% of iodine was I⁻ in the aqueous phase. The distribution coefficient of organic iodine in the soil-water system was more than 10-fold greater than that of iodide. Soil incubation experiments demonstrated that dissociation of iodine from organic iodine to I⁻ occurred under anoxic condition. Mobility of iodine is strongly affected by organification of iodine under oxic condition and dissociation from organic matter as I⁻ under anoxic condition.

[1] Yamada *et al.* (1996) *Soil Sci. Plant Nutr.* **42**, 859–866.

[2] Shimamoto & Takahashi (2008) *Anal. Sci.* **24**, 405–409.

[3] Shimamoto *et al.* *Environ. Sci. Technol.* in press.

Comparison of ⁴He and ¹⁴C dating, noble-gas temperatures and stable isotope ($\delta^2\text{H}$, $\delta^{18}\text{O}$) data for groundwater in stratified aquifers (Tomsk-7, S.E. Siberia)

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The groundwater of six stacked aquifers in the south-eastern part of Siberia near the former Tomsk-7 nuclear research facility has been studied.

Groundwater ages were estimated by ⁴He concentrations and ¹⁴C-activities, and paleoclimate conditions were reconstructed using dissolved noble gas concentrations (and the corresponding noble-gas temperatures) in combination with stable isotope data ($\delta^2\text{H}$, $\delta^{18}\text{O}$) [1, 2].

⁴He ages of the four lower aquifers vary from 2 to 15 ka, and increase with depth and along the flow path with increasing distance from the recharge area. Depleted $\delta^2\text{H}$, $\delta^{18}\text{O}$ as well as noble-gas concentrations based recharge temperatures of 0.5–2 °C indicate that the water infiltrated during cold climate state. Such cold climate conditions prevailed in the studied region between 5 and 18 ka BP.

In general, ¹⁴C-ages for the four lower aquifers are consistent with the He-ages (6–33 ka), whereby the ¹⁴C ages tend to be higher than He-ages. The estimation of the ¹⁴C-ages is quite robust as the aquifer matrix hardly contains any carbonates. The age difference can be explained by uncertainties in the calculation of the He-ages, which is strongly depends on the assumed aquifer porosity. The mean porosity is only vaguely known due the interbedding of sands and clays.

A strong shift of $\delta^2\text{H}$ and $\delta^{18}\text{O}$ data in the upper aquifer layers indicates that these layers were temporarily frozen during the Younger Dryas.

In conclusion, stable isotopes, noble-gas temperatures, and dating show consistent results and can be used to analyze groundwater dynamics on large time scales and to validate conceptual and numerical groundwater models.

[1] Tokarev *et al.* (2009a) *Water Res.* **36**, (2) 206–213.

[2] Tokarev *et al.* (2009b) *Water Res.* **36**, (3) 339–350.