

Rare Earth Elements in the sediments of Lake Baikal

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Lake Baikal is the deepest and oldest lake on Earth. However, the biogeochemical cycling of major and trace elements in this oligotrophic lake and its watershed have received relatively little scientific attention. The Rare Earth Elements (REEs), in particular, have gained importance as powerful tracers of chemical processes on the Earth's surface as they form a relatively coherent group of elements with, nonetheless, sensible differences among them. Cerium (Ce) and Europium (Eu), for example, are the only REEs which exhibit redox-sensitivity. The present study offers an overview over the REE chemistry in Lake Baikal and its catchment area and more specifically their distribution in five short sediment cores distributed across the Lake at different depths whereby we analysed and discussed normalised REE patterns and their consequential Ce, Eu and gadolinium (Gd) anomalies. We found that, while particulate REE concentrations are mainly influenced by processes above or near the surface of Lake Baikal, such as the development of a widespread negative Ce anomaly, early diagenetic chemical activity is best reflected in the dissolved fraction of the REEs, where their complexation with inorganic and organic ligands plays an important role in addition to adsorption onto metal oxides and clay minerals. A further extraordinary feature found within the lake's sediments are highly positive Eu anomalies, which are otherwise rare in sedimentary systems, in particular within Fe- and Mn-oxide accumulations buried within the reducing part of the sediment. Eu anomalies correlate with elevated barium (Ba) contents which are likely associated with phosphates and/or manganese oxides and we argue that Eu substitutes for Ba. Furthermore, while the Ce and Eu anomalies are formed within the watershed and the sediment respectively, the omnipresence of positive Gd anomalies in the sediment and the pore waters can be traced back to the atmospheric input into the lake.

Uptake of radiocesium by crops from soils contaminated by the Fukushima Accident

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Cs-137 ($T_{1/2}$: 30.1 y) and Cs-134 ($T_{1/2}$: 2.06 y) were released by the accident of Fukushima Daiichi NPP and agricultural fields in Fukushima prefecture were widely contaminated. More than 2 years after the accident, some crops exceed the guideline for radiocesium (100 Bq/kg) and the mechanism of higher uptake is poorly understood. We investigated radiocesium and stable element concentrations in rice plants and komatsuna (a leafy vegetable) grown in soils which were collected from the contaminated fields in Fukushima Prefecture. We discuss mechanisms of radiocesium transfer with special reference to the soil characteristics in this study.

Cultivation experiments using soil that was contaminated with radiocesium were carried out in Fukushima Agricultural Technology Centre and the radiocesium concentrations of both soil and plant samples were determined by a Ge-detector at Gakushuin University. The plants were cultivated in Wagner pots (3 L) in a greenhouse.

As a results, the highest values for transfer coefficient were observed in crops grown in brown forest soils, while the plants cultivated in gray lowland soil showed the lowest values. In order to compare soils with different radiocesium levels, we collected them from the top layer with high radiocesium concentrations (upper 5 cm) and from the underlying soil with lower concentrations (5–15 cm). We cultivated komatsuna and found that the transfer coefficients of plants grown in the underlying soils are greater than those of komatsuna planted in the surface soils. This might be related to the speciation of radiocesium in the soils. Deeper layers may have more labile, plant-available radiocesium, while less labile particulate-bound radiocesium from the accident may be more common in the surface soils.

Additionally, we have also carried out stable element analysis (including Cs) in crops and soil extracts to examine whether there is any correlation between the transfer factor of radiocesium and that of stable elements.