8–12 Remobilization Mechanism of Radiocesium from Bottom Sediments in Reservoir
—Vertical Distribution of ^{137}Cs in Sediment-Pore Water—

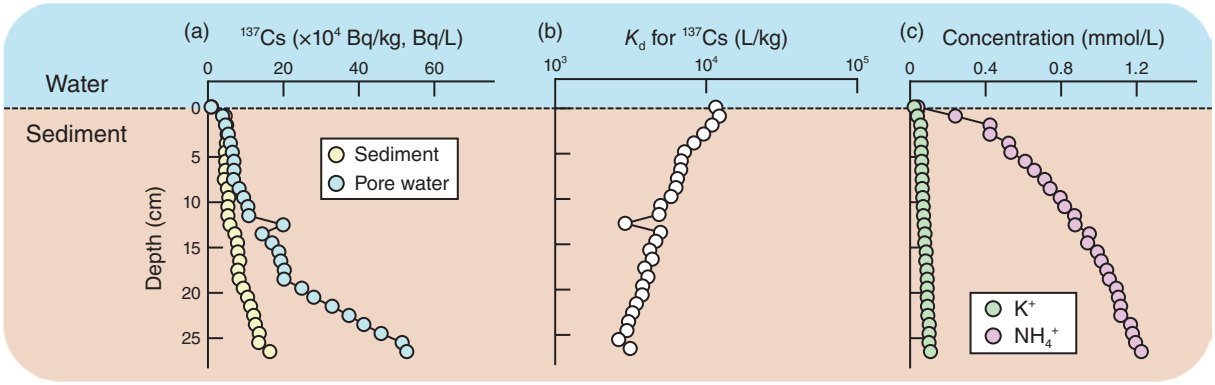

Fig.1 Vertical distribution of ^{137}Cs and water quality in sediment-pore water
Vertical distribution of (a) ^{137}Cs activity concentrations, (b) distribution coefficient (K_d) values for ^{137}Cs in sediment-pore water and (c) water quality in the Ogaki Dam Reservoir in July 2019.

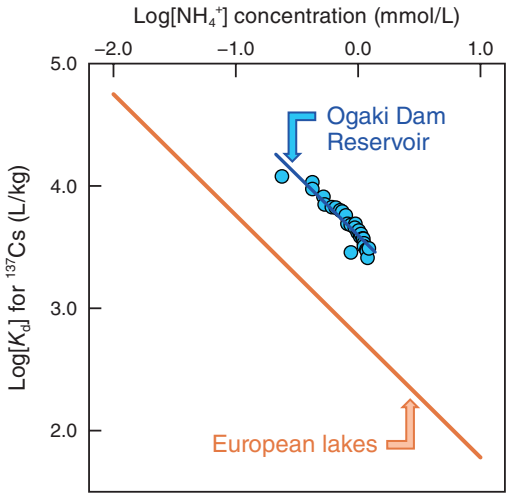

Fig.2 Correlations between the K_d values for the ^{137}Cs and NH_4^+ concentration in pore water
The blue color line indicates the exponential regression line of the Ogaki Dam Reservoir. The orange color line denote the previously reported exponential regression line in European lakes (Comans, R.N.J. et al.*).

Reservoir sediments generally act as a sink for radionuclides derived from nuclear accidents, but under anaerobic conditions, several radionuclides remobilize in bioavailable form from sediments to water columns, which may contribute to the long-term contamination of aquatic products. This study systematically investigated the ^{137}Cs activities of sediment–pore water, providing a direct evidence of the remobilization of bioavailable ^{137}Cs from sediments in a highly contaminated reservoir (Ogaki Dam Reservoir) affected by the TEPCO's Fukushima Daiichi Nuclear Power Station accident.

We observed that the dissolved ^{137}Cs activity concentration of pore water (3.0–65.8 Bq/L) was one to two orders of magnitude higher than that of reservoir water (Fig.1(a)). The distribution coefficient (K_d) values for the ^{137}Cs of sediment–pore water ranged from 2.6×10^3 L/kg to 1.2×10^4 L/kg and decreased with depth (Fig.1(b)). The major ^{137}Cs competing cation NH_4^+ (0.24-1.22 mmol/L) was significantly higher than the K^+ concentration (0.04-0.11 mmol/L) (Fig.1(c)). Moreover, the K_d values were significantly and negatively correlated with the NH_4^+ concentration and the exponential regression lines follow a straight line with an approximate slope close to −1 (Fig.2).

These results strongly indicate that the competitive ion exchange process between ^{137}Cs and NH_4^+ through a highly selective interaction with the FESs of clay minerals is the major reason for the variability of K_d values between sediments and pore water. However, when compared under similar NH_4^+ concentrations, the K_d values in Ogaki Dam Reservoir were higher than in some European lakes, suggesting that the sediments of Ogaki adsorb ^{137}Cs strongly and are less likely to remobilize (Fig.2).

Our findings provide important parameter values for mid- and long-term assessments of the radiation impact of radionuclide discharges to freshwater environments.

(Hironori Funaki)

* Comans, R.N.J. et al., Interpreting and Predicting *in Situ* Distribution Coefficients of Radiocaesium in Aquatic Systems, Studies in Environmental Science, vol.68, 1997, p.129–140.

Reference

Funaki, H. et al., Remobilisation of Radiocaesium from Bottom Sediments to Water Column in Reservoirs in Fukushima, Japan, Science of The Total Environment, vol.812, 2022, 152534, 10p.