

Distributions of selenium, iodine, lead, thorium and uranium in Japanese river waters

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ABSTRACT

Long-lived radionuclides released from nuclear facilities, such as deep underground disposal facilities, could reach humans through several transfer paths in the environment. Uses of ground water and river water for agricultural field irrigation and for drinking water are important paths. In order to understand behavior of long-lived radionuclides in the terrestrial water environment, we carried out a natural analogue study, that is, measurement of selenium (Se), iodine (I), lead (Pb), thorium (Th) and uranium (U) concentrations in 45 Japanese rivers at 10 sampling points from the upper stream to the river mouth for each river. Geometric mean concentrations for Se, I, Pb, Th and U were 0.057, 1.4, 0.039, 0.0055, 0.0109 ng/mL, respectively. Distribution patterns from upper stream to river mouth were different by elements, for instance, the concentrations of I, Th and U increased when the sampling points were nearer the river mouth, while that of Se were almost constant. For Pb, the highest value was observed in the middle part of each river in many cases.

INTRODUCTION

During these 40 some years, radioactive wastes have been produced and their management, treatment, and disposal have become very important issues. High level radioactive wastes are expected finally to be buried deep underground which will prevent the radioactive materials from entering the biosphere where they could affect human health. Both artificial and natural barriers will be used to control mobility of the radioactive materials in their deep underground environments.

Safety assessments on deep underground disposal of high level radioactive wastes can consider many scenarios; one important scenario is transfer of radionuclides from the deep underground disposal sites via underground water movement, so that they finally reach the biosphere and most of them would likely enter into rivers. Since river waters are used as irrigation water for agricultural fields and also for drinking water, we collected river water samples from 45 major rivers throughout Japan and determined their major and trace element concentrations to understand the distribution of selenium (Se), iodine (I), lead (Pb), thorium (Th) and uranium (U) concentrations in 45 Japanese rivers at 10 sampling points from the upper stream to the river mouth for each river.

EXPERIMENTAL

Ten samples per river were collected from the upper stream to the river mouth. Only 2-3 days were spent in collection at any one river, because river conditions can be affected by the weather

and the season. River water samples were collected in clean-washed 100 mL polypropylene bottles. Each 100 mL bottle was filled with pretreated river water (<0.45 μm , acidified with HNO_3) which was later directly used for laboratory measurements of Se, I, Pb, Th and U by inductively coupled plasma mass spectrometry (ICP-MS). The measurement conditions were reported previously [1-3]

RESULTS AND DISCUSSION

The cumulative probability distributions of Se, I, Pb, Th and U concentrations were on log-normal lines and their geometric mean concentrations were 0.057, 1.4, 0.039, 0.0055, 0.0109 ng/mL, respectively. As can be seen from Figs.1 and 2, the concentrations of I, Th and U in each river increased when the sampling points were nearer the river mouth, while that of Se were almost constant. For Pb, the highest value was observed in the middle part of each river in many cases. (Note: sampling number 1 is the uppermost sampling site and sampling number 10 is the lowermost site).

When Th and U concentrations were compared, 90% of the sampled water had higher U/Th concentration ratio than those observed in agricultural field (0.5) [4]. Mobility of U in rock and soil would be higher than that of Th so that the concentration ratio was increased. Moreover, addition of phosphatic fertilizers to agricultural field enhances U concentrations in river waters.

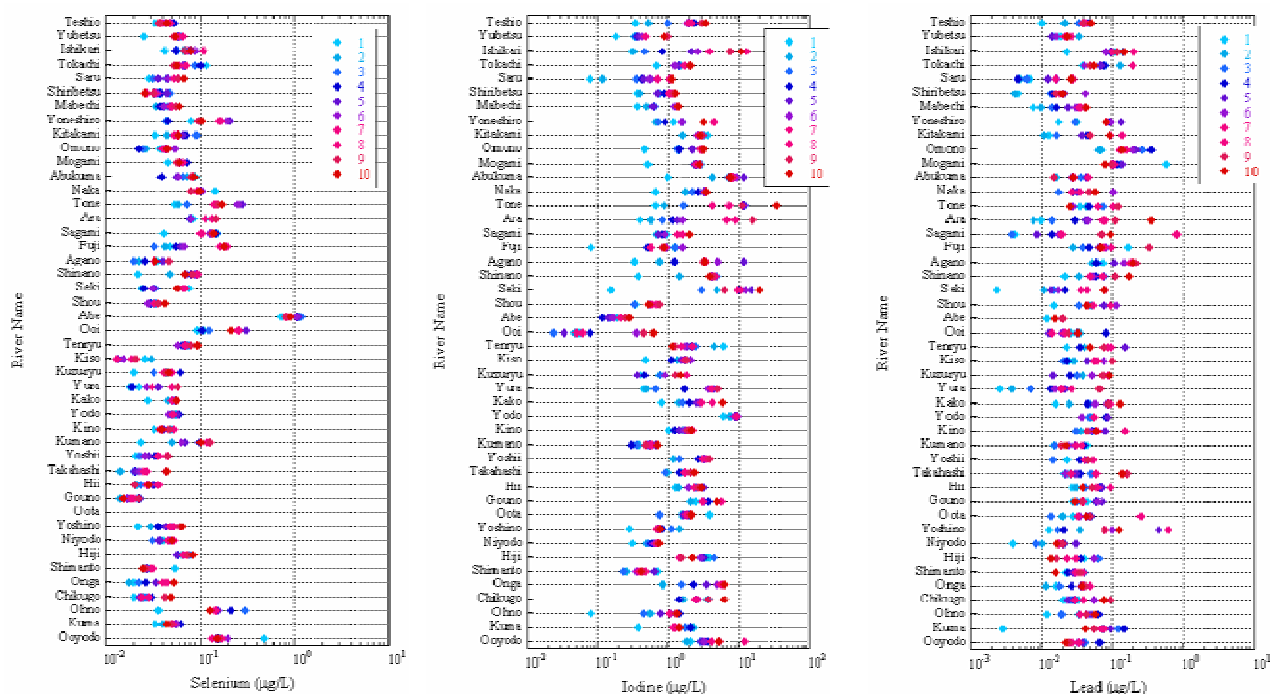


Fig. 1. Concentrations and distributions of Se (left), I (center), and Pb (right) in Japanese river waters.

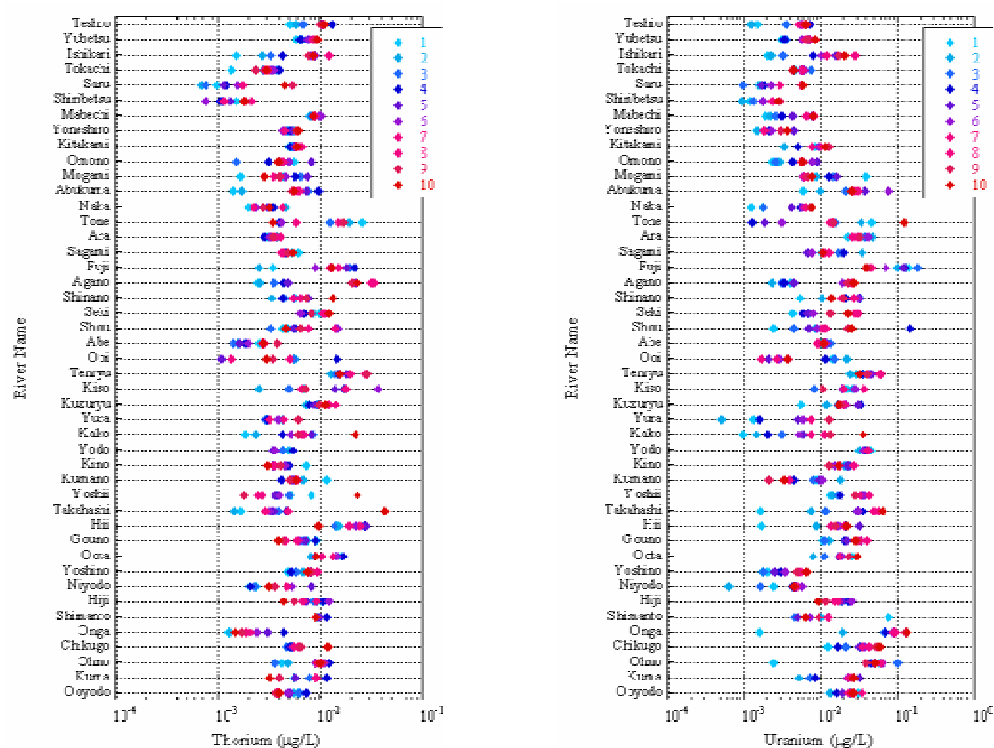


Fig. 2. Concentrations and distributions of Th (left) and U (right) in Japanese river waters.

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