**Partitioning of plutonium between bottom waters and sediments in the Far Eastern Seas**

**Katsumi Hirose,1,\* Daisuke Tsumune****,2 Aya Sakaguchi, 2 and Pavel P. Povinec3**

*1Laboratory for Environmental Research at Mount Fuji, 169 0072 Tokyo, Japan*

*2Tsukuba University, 305 8572 Tsukuba, Japan*

*3Comenius University, 842 48 Bratislava, Slovakia*

\* *e-mail:* [*hirose45037@mail2.accsnet.ne.jp*](mailto:hirose45037@mail2.accsnet.ne.jp)

Plutonium in marine environments has predominantly been injected to ocean surface by global fallout owing to atmospheric thermonuclear testing in the early 1960s, and close-in fallout in the early 1950s to the North Pacific. As a result, the seabed sediment in the world ocean has been contaminated by plutonium isotopes. It is an important issue whether deep ocean sediment is one of the final sinks of plutonium or not. There is little knowledge about the transport processes ofplutonium isotopes from water columns to sediment in the deep ocean. As possible mechanisms, partitioning between bottom water and surface sediment, direct input of sinking particles, and deep-ward transport of resuspended shallow sediment particles have been speculated. To elucidate the behaviors of plutonium in the sediment of deep oceans, it is important to clarify the temporal change of plutonium in the sediments, as does plutonium in bottom water. However, there is little information on the temporal variability of plutonium in deep ocean sediment. After the report of the Russian radioactivity dumping in the Far Eastern Seas (the Sea of Japan and Okhotsk Sea) in 1993, the monitoring of radionuclides in the water column and sediment has been conducted by the Hydrographic Department of Japan Coastal Guard (JCG). To better understand the biogeochemical behavior of 239,240Pu in the Far Eastern Seas, we examined the temporal changes of 239,240Pu activity concentrations in bottom waters and sediments of the Far Eastern Seas (Sea of Japan: SOJ, and Okhotsk Sea: OS) during the period of 1994 to 2021. The 239,240Pu activity concentrations in bottom waters ranged from 5 to 83 mBq m-3, in which 239,240Pu in each site did not show clear trends during 1994 -2021, except shallow sites, in contrast to those of 137Cs in the Far Eastern Seas. The 239,240Pu activity concentrations in the sediments, ranging from 0.003 to 2.25 Bq kg-1dry, showed high variability. The 239,240Pu activity in sediments at each site did not show clear trends during the corresponding period, except St. 3 and 8, where high variability was observed. If temporal changes of the 239,240Pu activity concentration in the bottom water and sediments are governed by exponential processes, we calculated the change rates of 239,240Pu in the bottom water and sediments. Change rates of 239,240Pu in the bottom water of the SOJ were nearly zero, except shallow SOJ and OS. Change rates of 239,240Pu in the sediments were nearly zero, except for two sites, although showing large uncertainties. To elucidate the transfer processes of 239,240Pu from seawater to sediment, we introduced practical partition coefficients (Kd) of 239,240Pu between bottom water and surface sediment. The Kd values, ranging from 1.1 ×102 to 2.8 ×105 L kg-1, showed large variability. However, the Kd values of 239,240Pu in each site did not show trend, except St. 3 and 8. The Kd values of 239,240Pu decreased with increasing depth, in contrast to 137Cs. These findings suggest that chemical processes may be important as factors controlling the movement of 239,240Pu between seawater and sediment in deep waters.