

Exchange of radiocesium between sediment and pore water in the coast off Fukushima

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In the coastal region of Fukushima, ^{137}Cs concentration which is higher than before the accident is detected from the seabed even though the concentration in seawater has declined sufficiently. From this fact, it is pointed out that seabed sediment can be a source of radiocesium to coastal areas. In this study, behavior of dissolved radiocesium near the seafloor is discussed from the distributions of ^{137}Cs in seawater, seabed sediment and pore water collected from the area around Fukushima. Between October 2015 and September 2017, seawater and surface (0~10 cm) sediments were collected at 17 stations at 1.5~105 km away from the Fukushima Daiichi Nuclear Power Plant. Seawater was collected at the surface layer (0~3 m depth), intermediate layer (5 m above the seabed), and the layer immediately on the seabed (overlying layer with 0.3 m in thickness). At four stations, pore water in sediment was also collected. The ^{137}Cs concentration in seawater and sediment was measured by gamma-ray spectrometry. The ^{137}Cs concentration in the overlying water ranged from 5 to 283 mBq L^{-1} , and was 2~3 times higher than that in the intermediate layer water. The ^{137}Cs concentration in the pore water was 33~1166 mBq L^{-1} , which was 10~40 times higher than that in the overlying water. The ^{137}Cs concentration in the overlying water did not show clear differences regardless of the pore size (0.45 μm , 0.2 μm and 1 kDa) of the filter used for filtration. From these results, it was confirmed that radiocesium in the seabed sediment was "dissolved" in pore water and diffused to the benthic layer. The ^{137}Cs abundance in the pore water in the surface sediment corresponded to 0.1~0.6% of the ^{137}Cs existing in the solid phase of sediment. At most stations, the ^{137}Cs concentrations in the overlying water and the pore water were approximately proportional to those in the sediment. The apparent distribution coefficient between pore water and sediment was $[0.9\text{-}4.2]\times 10^2 \text{ L kg}^{-1}$, with no difference depending on the year of sampling. These results indicated that equilibrium of ^{137}Cs between pore water and sediment has established in a relatively short period. From the above-mentioned results and kinetic parameters such as ^{137}Cs desorption rate from sediment obtained from laboratory experiments, we estimated the mass balance of ^{137}Cs in the sediments and the overlying water along the coast of Fukushima. The results showed that the ^{137}Cs in the sediment was reduced by about 4~9% per year by desorption/diffusion of ^{137}Cs from the seabed. This rate was lower than the reduction rate of ^{137}Cs in sediments (~29%) observed in this region, and it was estimated that this process was not the main factor of decreasing the ^{137}Cs inventory in sediments. In addition, as of 2017, since the ^{137}Cs concentration presumed to migrate to benthos via the pore water will not exceed the regulatory limit of fishery products, the impact of supply to the benthic environment of ^{137}Cs is considered to be limited.

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