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Distribution of ^{137}Cs, $^{239+240}Pu$ and $^{240}Pu/^{239}Pu$ atom ratios in marine surface sediments around the Korea Peninsula

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Introduction

The major source of artificial radionuclides in the ocean is the global fallout derived from atmospheric nuclear testing. Other sources are close-in fallout from nuclear weapons testing and accidents such as the Chernobyl incident.

In the marine environment, anthropogenic radionuclides entering the ocean are circulated by physical and biogeochemical processes, and ultimately arrive on sediments by scavenging and sedimentation process.

Analysis of long-lived anthropogenic radionuclides such as ^{137}Cs and Pu isotopes which are powerful tracers in the study of marine environment, is important to monitor the radioactive pollution.

In the marine environment, sediments play an important role in marine ecology by serving living place and food of benthic organisms, and have records of environmental status in the past days. Although several studies about the distribution and source of artificial radionuclides in the sediment have been conducted in the East Sea, investigations throughout the Yellow Sea and Korea Strait are rare.

In this study, the distribution of ^{137}Cs and $^{239+240}Pu$ concentration and $^{240}Pu/^{239}Pu$ atom ratio in surface sediment around the Korea Peninsula (East Sea, Yellow Sea, Korea Strait) are discussed.

Materials and Methods

Marine surface (~ 5 cm) sediments were collected at 37 stations around Korea from 2005-2007. ^{137}Cs concentrations were analyzed by using HPGe gamma ray spectrometry. $^{239+240}Pu$ and $^{240}Pu/^{239}Pu$ atom ratio were determined by inductively coupled plasma mass spectrometer (ICP-MS) after separation by extraction chromatography.

Results and Discussion

Table 1 shows the activities and ranges of ^{137}Cs and $^{239+240}Pu$ in surface sediments around Korea Peninsula. The mean activities of ^{137}Cs and $^{239+240}Pu$ in sediments were 1.89 and 0.334 Bq/kg-dry, respectively, which are in good agreement with the values reported by others for marine surface sediments in the East Sea.

Both ^{137}Cs and $^{239+240}Pu$ mean activities in the Korea Strait were higher than those in other regions (East Sea, Yellow Sea). It is considered that scavenging by organic matter was happened easily in the Korea Strait due to high primary

productivity. Although the Yellow Sea has also plentiful organisms in surface water, the average activity in the surface sediment was lower than that in the Korea Strait and similar with the mean concentration in the East Sea. This result seems to be due to the mixing precess between high-activity surface sediment and low-activity subsurface sediment caused by the frequent resuspension and settling of particle matter in the sediments owing to strong tidal current in the Yellow Sea.

Table 1. The mean activities and ranges of ^{137}Cs and $^{239+240}$Pu

Region	^{137}Cs(Bq/kg-dry)		$^{239+240}$Pu(Bq/kg-dry)	
	Mean value	Range	Mean value	Range
East Sea	1.43 (11)**	0.84-3.34	0.190 (6)	0.09-0.34
Yellow Sea	1.77 (10)	0.80-3.34	0.188 (6)	0.10-0.46
Korea Strait	2.42 (12)	1.35-3.57	0.583 (7)	0.19-0.98
All of study area	1.89 (33)	0.80-3.57	0.334 (19)	0.09-0.98
East Sea*	-	0.4-9.1	-	0.002-1.9

* S. Otosaka et al. (2006)
** The number of data

The activities of ^{137}Cs in surface sediments increase linearly with an increase of $^{239+240}$Pu activities (Fig. 1). This result indicates that ^{137}Cs and $^{239+240}$Pu have similar behavior in this region.

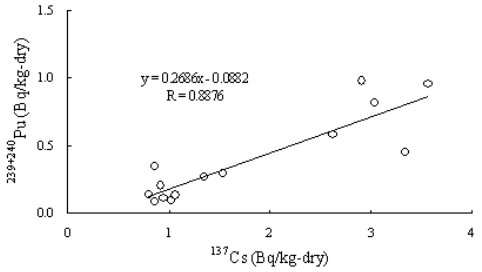

Fig. 1. Plots of activities of $^{239+240}$Pu vs. ^{137}Cs

The $^{239+240}$Pu/^{137}Cs activity ratios in surface sediments were in the ranges of 0.093-0.392 with mean values of 0.202. These values are higher than global fallout level of 0.03 [1], indicating that $^{239+240}$Pu has higher scavenging rate than ^{137}Cs in surface sea water.

The ^{240}Pu/^{239}Pu atom ratios of surface sediment samples are given in Table 2. Although the average of ^{240}Pu/^{239}Pu atom ratio in the Yellow Sea was relatively lower than the East Sea and Yellow Sea, the mean value around Korea Peninsula was higher than global fallout ratio of 0.18. This can be explained by that seawater in this study area seems to be affected by influx of Pu representing relatively high ^{240}Pu/^{239}Pu atom ratio derived from nuclear testing in the Pacific.

Table 2. The $^{239+240}$Pu/^{137}Cs activity ratios and ^{240}Pu/^{239}Pu atom ratios

Region	$^{239+240}$Pu/^{137}Cs activity ratio	^{240}Pu/^{239}Pu atom ratio
East Sea	0.21	0.24
Yellow Sea	0.15	0.20
Korea Strait	0.25	0.24
Global fallout	0.03	0.18

Conclusion

The distribution of ^{137}Cs, $^{239+240}$Pu, and ^{240}Pu/^{239}Pu atom ratio in marine surface sediments around the Korea peninsula was discussed. The mean activity of radionuclides (^{137}Cs, $^{239+240}$Pu) in the Korea Strait was relatively higher than those in the East Sea and Yellow Sea. ^{137}Cs and $^{239+240}$Pu showed similar behavior in this study. The ^{240}Pu/^{239}Pu atom ratio around the Korea Peninsula was higher than global fallout value. The result can be important background information to monitor and assess the marine radioactivity pollution around the Korea Peninsular.

Reference

1. UNSCEAR, 2000. Sources and effects of ionizing radiation. UNSCEAR 2000 Report, Scientific Annex C, United Nations, New York.
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