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Distribution of Radioactive Cesium in Sea Sediment and Bottom Boundary Layer after the Fukushima Daiichi Nuclear Power Plant Accident

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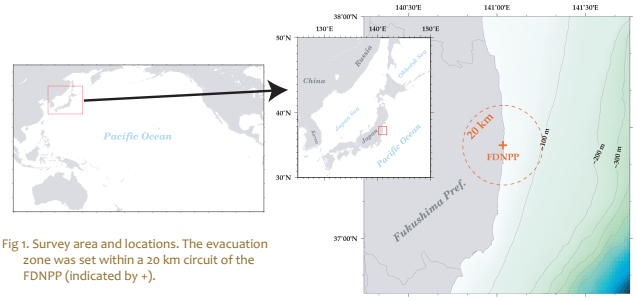
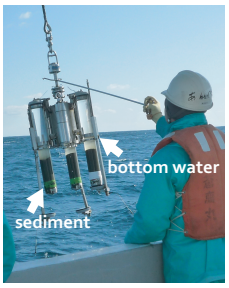


Fig 1. Survey area and locations. The evacuation zone was set within a 20 km circuit of the FDNPP (indicated by +).

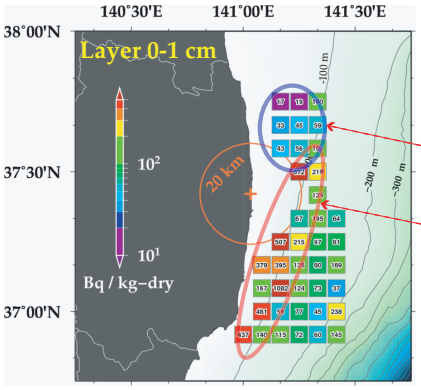
Objective and Materials

A large amount of radioactive materials was discharged into the western North Pacific Ocean by the Fukushima Daiichi Nuclear Power Plant (FDNPP) disaster following the Great East Japan Earthquake and tsunami on 11 March 2011. One of the emerging fisheries issues is to comprehend the effects of the radioactive materials on demersal fishes. For this purpose, we conducted a basic study on radioactive cesium concentrations in sea sediment off Fukushima in February of 2012. Undisturbed sea sediment columns of 14-cm-high were collected with bottom water at 40 locations which were arrayed every 5 minutes.



Results and Discussions

Horizontal spatial pattern of ^{137}Cs in sea sediment



- Main spatial variation scale is 10^1 km order. However, the concentrations between the adjacent grids often have a large difference, suggesting that sub-grid scale variations are also predominant.
- The concentrations were often lower in northhern area from the FDNPP than those in southern area.
- Higher concentrations were especially along the 100 m isobath.
- These horizontal characteristics were commonly observed in all layers.

Fig. 2. Concentrations of ^{137}Cs in each sliced sediment (0-1, 1-+2, 2-4, 4-6, 6-10 and 10-14 cm)

Vertical profiles of ^{137}Cs

- Almost concentration peaks were found in upper two layers (0-1 and 1-2 cm).
- The concentration values generally exponentially decayed with the sediment layer depth.
- Most of the sampled radioactive cesium (more than 90 %) distributed 0-10 cm layers.
- Amount of total ^{137}Cs in this surveyed area (Fig. 2) was estimated about 0.3 % of the total discharge from the FDNPP (3.6×10^{15} Bq)

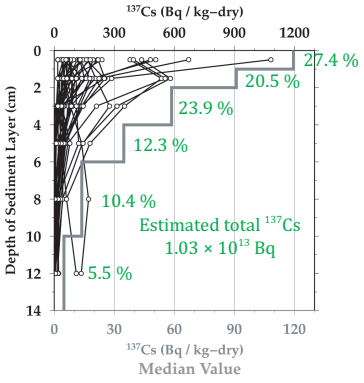
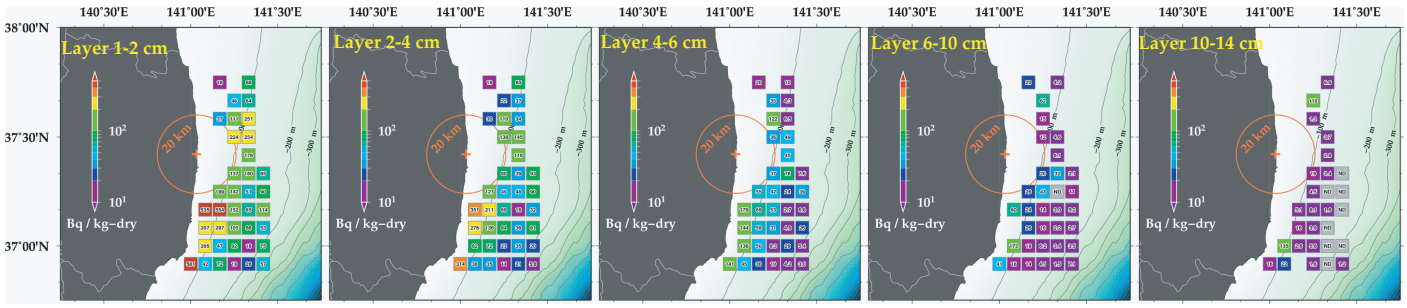


Fig. 3. Vertical profiles of the ^{137}Cs concentration in the all surveyd positions (black lines). Gray bold line indicates median value in each layer.



Grain size of the sediment

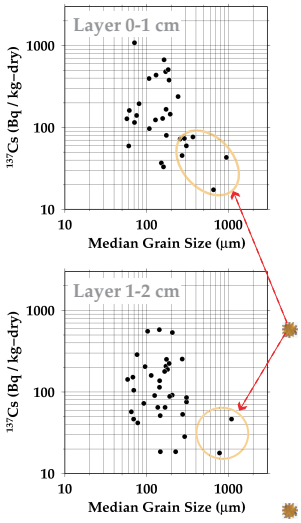


Fig. 4. Scatter plot between the ^{137}Cs concentration and the median grain size of the sediment in the 0-1 cm and 1-2 cm layers.

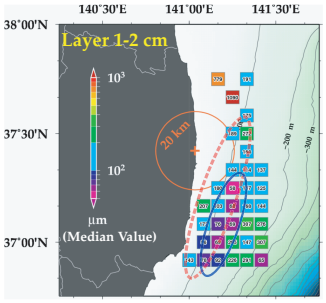


Fig. 5. Median grain size of the sea sediment in the 1-2 cm layer. Red dotted ellipse indicates the area where high ^{137}Cs concentrations were found (Fig. 2).

- The high ^{137}Cs concentrations did not appeared in lager grain areas which located in the northern near-shore region.
  - Sediment composition associated with the grain size is suggested as one of the factors in forming the distribution of radioactive cesium at the sea bottom.
- Smaller grains were found parallel to the high ^{137}Cs concentrations in the southern region with some spatial distance (blue ellipse in Fig. 5).

^{137}Cs of suspended particles in the bottom boundary layer (0-15 cm from sea-bottom)

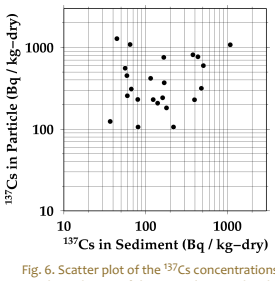


Fig. 6. Scatter plot of the ^{137}Cs concentrations in the sediment of the 0-1 cm layer and in the suspended particles .

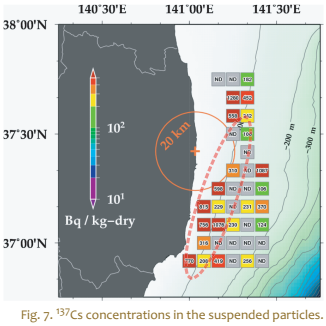


Fig. 7. ^{137}Cs concentrations in the suspended particles.

- Correlation between the consentrations of sediment and suspended particles was not significant (Fig. 6).
- Relative high values were often detected around the 100 m isobath (Fig. 7).
- But high values were also sometimes observed at offshore or nothern areas where the concentrations were not high in the sea sediment (Fig. 7).
  - The ^{137}Cs might be frequently transported in the bottom boundary layer.
  - If so, the formation of the radioactive cesium field on sea-bottom is still in transitional state at this time. Consecutive monitoring for comprehending the temporal variation is absolutely needed.

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