**Fukushima-derived radiocesium in the western North Pacific Ocean a decade after the accident**

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Introduction　The accident of Fukushima Dai-ichi Nuclear Power Plant (FNPP1) occurred on March 11, 2011, and resulted in the release of 30-40 PBq radiocesium (134Cs + 137Cs) into the environment. It has been estimated that 70-80% of the FNPP1-derived radiocesium was deposited and discharged in the North Pacific Ocean. The radiocesium deposited and discharged in the coastal area of Japan had been transported eastward to the international date line by the summer of 2012, the North American Continent by 2015, and then the Bering Sea through the Gulf of Alaska by 2017 along with the anti-clockwise subarctic surface current. Simultaneously, the FNPP1-derived radiocesium was also transported southward through the subsurface layer, about 200-400 m depth due to the subduction of the subtropical mode water (STMW) and central mode water (CMW) in the northwestern North Pacific Ocean just after the FNPP1 accident. Previous studies found that the FNPP1-derived radiocesium is a good tracer for the transport of the mode waters, which has not been revealed well. However, because observations of the vertical profile are limited, the temporal change in the FNPP1-derived radiocesium in the subsurface layers in the western North Pacific Ocean is unclear. We measured vertical profiles of radiocesium there in 2020-2022 and discussed its temporal change a decade after the FNPP1 accident.

Methods　We collected seawater samples during the R/V "MIRAI" cruises of MR20-05C in October 2020 and MR21-06 in November 2021 and the R/V “HAKUHO-MARU” cruise of KH-22-7 in July-August 2022. 40 L of seawater was collected from the surface (10 m) to 800 m depth at 12 stations from 25 to 47°N and from 150 to 170°E. Radiocesium in the seawater sample was concentrated using ammonium phosphomolybdate or KNiFC-PAN resin (Triskem International). The recovery rate of Cs from the seawater sample was about 95%. Activity concentrations of 134Cs and 137Cs were measured using gamma-ray spectrometers at Kanazawa University. The uncertainties of the 134Cs and 137Cs measurements were about 15–20% and 3–5%, respectively. The detection limits of the decay-corrected 134Cs and 137Cs concentrations were about 0.9 and 0.01 Bq m−3, respectively.

Results and Discussion　The FNPP1-derived 134Cs was still observed at all the stations a decade after the accident. The vertical profile of 134Cs activity concentration decay-corrected to the FNPP1 accident date was different between the subarctic and subtropical regions. The two regions are divided by the Kuroshio Front around 35°N. In the subarctic region, 134Cs was observed in the surface layer shallower than 300 m depth, corresponding to the maximum depth of the winter vertical mixing. The highest concentration (2.1 Bq m-3) was observed at 200 m depth, which could not be explained by the vertical mixing but by lateral mixing. We conclude that this highest concentration was derived from the return of the FNPP1-derived 134Cs along with the anti-clockwise subarctic current (Kumamoto et al., 2020) because that was higher than those in the subtropical region. In the subtropical region, 134Cs was detected from the surface to 600 m depth and the maximum concentration was observed around 400 m depth (the highest concentration was 2.0 Bq m-3). The subsurface maximum in the subtropical region was observed about 10 months after the accident, which was derived from the subduction of STMW (Kumamoto et al., 2014). Our results indicate that the FNPP1-derived 134Cs in STMW subducted in March 2011 still remained in the subtropical region of the western North Pacific a decade after the accident, suggesting that STMW has circulated with in the subtropical region of the western North Pacific.