Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.18023

Vertical observation of gamma-ray by in-situ gamma-ray sensor using plastic scintillator

KIMINORI SHITASHIMA

Tokyo University of Marine Science and Technology

Presenting Author: kshita0@kaiyodai.ac.jp

The high sensitivity and lightweight underwater in-situ gamma-ray sensor using NaI(Tl) doped plastic scintillator was developed for oceanographic applications. The plastic scintillator was coated by light-resistant paint and used as a part of pressure housing. Therefore, the sensor can expect high sensitivity because the plastic scintillator contacts seawater directly. This sensor consists of plastic scintillator, photomultiplier tube, preamplifier unit, high-voltage power supply, data logger and lithium-ion battery, and all parts are stored in a pressure housing.

Underwater in-situ gamma-ray measurement is important scientific priority for oceanography, especially for survey and monitoring of the concentration distributions of natural and anthropogenic gamma-ray. The sensor was applied to observe and monitor natural gamma-ray in the hydrothermal area and deep open ocean. The hydrothermal fluid contains high concentration of radon (one of the gamma-ray source) and hydrothermal radon is discharged into seawater. Radioactive elements are highly particle reactive and is readily scavenged with the biogenic particles.

In the shallow hydrothermal area, the sensor responded quickly to hydrothermal gamma-ray at seafloor and detected the hydrothermal radon to 20m above the hydrothermal point (seafloor). The sensor was moved along mapping grid (40m X 40m area, 5m intervals) at 1m layer above the seafloor by diver, obtained the contour map of hydrothermal radon diffusion. The signals of the sensor corresponded with radon concentration, sea water samples measured by liquid scintillation counter at mapping survey area, of 2 to 12 becquerels per liter. In the deep open ocean at the Gulf of Alaska and the Indian Ocean to 4,000m water depth, the vertical distributions of gamma-ray were obtained by the sensor attached to CTD-CMS system. The sensor showed high intensity at around 500m and provided very low strength at deeper than 1,000m. The vertical distributions of gamma-ray were similar to them of turbidity.

Since the sensor is small and lightweight, the sensor installed to an AUV (autonomous underwater vehicle) can perform automatic investigations of monitoring and mapping. Furthermore, underwater in-situ gamma-ray sensor has expectations of application to earthquake prediction and volcanic activity monitoring.