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Development of a stand-alone gamma-ray measuring system for long-term change at the sea floor, and first measurement

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In the Japanese Islands, the Tokai, Tonankai and Nankai earthquakes are expected within a few decades. It is a very important scientific issue to understand the physicochemical process occurring in the earthquake occurrence zone and the mechanism of earthquakes near the subduction zone for mitigation of casualties and social infrastructures. Increases of the radon concentration in atmosphere and in groundwater before earthquake are reported in the Southern Hyogo Prefecture Earthquake in 1995. The correlation between micro earthquakes and concentrations of radionuclides is expected to contribute the fundamental research on the response of the fluid in the crust corresponding to change of the crustal stress. Then this time, environmental gamma ray measurement derived from natural radionuclides at the deep-sea floor in the Kumano-basin, where the epicenter of the coming Tonankai earthquake has been inferred.

To date, submarine environmental radiometry around Japan has been mainly performed by diving of a manned submersible ”Shinkai 6500/2000” or a remotely operated vehicles, e.g. ”hyper-dolphin” At such measurement, the NaI gamma-ray instrument was connected by cable to power supply and data transfer (cable-tethered NaI). Thus, the spatial distribution of environmental radioactivity has limitedly been measured around diving points. On the other hand, it was impossible to measure radiation at a fixed point for a long period. Subsequently, an automatic recording gamma- ray measurement system (GRAMS [Gamma RAy Monitoring System]) was developed, and it made possible to measure submarine gamma-ray at a fixed point. But gamma ray measurement has been performed only for short period of 12 days so far.

This time we developed a new stand-alone NaI gamma-ray measuring system (stand-alone NaI) for long-term monitoring of radiation at the deep-sea floor. This system has following features; 1. It has intermittent operation mode to save power consumption. 2. An automatic shut-down function to suspend the measurement when a battery voltage falls below the threshold (for example, 6V). 3. Low power consumption: the requirement of cable-tethered NaI is 12V 170mA (2W) regardless of that of stand-alone NaI is 6V 110mA (0.66W). Thus, the power consumption decreases in 1/3 even in measurement. It enables gamma-ray measurement for long-term temporal change of submarine environmental radiation at a fixed point. Its power is supplied by 180 AA alkaline batteries, then running cost becomes dramatically inexpensive.

As first measurement, we measured secular fluctuation of radiation from 24th April to 3rd August (about 3.5 months) at a cold seepage on Kumano-Basin. Respective U, Th and K contents was calculated as almost constant of 0.19+-0.07 ppm, 0.07+-0.07 ppm and 0.05+-0.01wt.% in surrounding seawater. There was no large fluctuation. However, after Fourier analysis, a feeble peak of 25 hours, which corresponded to tidal fluctuation, has come out.

Keywords: radiation, sea floor, long-term temporal change, NaI, gamma-ray