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Role of animal teeth for estimation of environmental pollution of Sr-90 and Cs-137 just after the Fukushima Daiichi Power Plant Accident

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The Fukushima-Daiichi Nuclear Power Plant (FNPP) accident released a substantial amount of radioactive nuclides into the atmosphere and caused extensive contamination of the environment. Cs-137 and Sr-90 are typical fission nuclides that have a great influence on the environment for several ten years after the accident because of its half-life (30.1 y and 28.9 y). After the deposition onto the environment, the nuclides diffused into soil, plant, and water. Specific activities (ratio of radioactivity to the mass of the element in the sample) are associated with incorporation of the radionuclide into animals and plants. However, the specific activities should have drastically changed in the first a few years. Since the FNPP accident, several years have passed and the landscape has changed. The pollution has been decreased around the FNPP by both decontamination and weathering. Thus, it has become very hard to estimate the initial deposition and the internal and external exposure in the early stage.

Formation mechanisms of teeth are quite unique because replacement of component hardly occurs after the formation stage of the teeth. The present authors reported that the concentration of Sr-90 in teeth formed after the FNPP accident reflects Sr-90 pollution in the environment [1, 2].

In this paper, we propose the alternative way to estimate the initial deposition and past incorporation of the radionuclides into animals. We will discuss past pollution of Sr-90 and Cs-137 estimated from animal teeth. Cattle were collected near the FNPP (5 km west from the FNPP (10-30 $\mu\text{Sv/h}$) and 16 km southwest from the FNPP (1 $\mu\text{Sv/h}$)). We collected young cattle (teeth were developing at the accident). Radioactivity of Sr-90 was determined with a gas-flow GM detector after chemical separations. Radioactivity of Cs-137 was determined with a Ge detector.

Specific activities of Sr-90 in the teeth were compared with those in soluble fractions of soil. The results suggest that Sr-90 in the soluble fractions of the soil might migrate into teeth and contributed to the amount of Sr-90 in the teeth. Thus, the specific activities of Sr-90 in teeth reflect the extent of Sr-90 pollution in the environment and incorporation in the cattle during the formation stage.

Specific activities of Cs-137 in the teeth were compared with those in internal organs. The results indicate that Cs-137 in the teeth recorded high incorporation until the collection time. Cs-137 in the teeth indicated past incorporation from polluted environment because component in the teeth hardly replace after the formation stage.

It is concluded that Sr-90 and Cs-137 in teeth could be indicators of past pollution in the environment and incorporation into the cattle.

[1] K. Koarai et al., Sci. Rep., 7, 24077 (2017).

[2] K. Koarai et al., J. Environ. Radioact., 183, 1-6 (2018).

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