^{90}Sr in mammal teeth taken in the Semipalatinsk Test Site measured by imaging plates

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Abstract

The concentrations of ^{90}Sr in mammal teeth taken in north-west part of Semipalatinsk Test Site were measured by using imaging plates. The highest concentration detected in the present study was 13Bq/g, being comparable with the values previously detected in cow teeth from South Ural region. It suggests that, at least locally, the soil in north-west part of the Test Site is possibly highly contaminated. It would be necessary to investigate the source of this high level of contamination, such as radiological weapon tests, before providing the land for agricultural use.

INTRODUCTION

Measurement of ^{90}Sr by imaging plate (IP) is an easy and sensitive method to determine the ^{90}Sr concentrations in materials. The concentrations of ^{90}Sr in human teeth taken from South Ural region were first measured by this method to show that the part in human teeth in which ^{90}Sr is concentrated depends on the time of intake in relation with the formation of the teeth [1]. We have investigated the best experimental conditions for the BAS-1800II system for quantitative measurements of ^{90}Sr in teeth and also shown that a KCl crystal can be used as a universal standard [2]. Subsequently, it was shown that the method is also useful to evaluate the ^{90}Sr concentrations in mammal teeth [3]. In the latter paper, it was shown that the ^{90}Sr concentrations in cow teeth are correlated with the levels of ^{90}Sr contamination in soil in South Ural region and that ^{90}Sr is also detected in mammal teeth taken from Semipalatinsk Test site region.

EXPEIMRNTEAL

In the present study, additional mammal teeth were taken from north-west part of Semipalatinsk Test Site, such as teeth of domestic cows and goats, wild deer and hares as shown in Table 1.

The teeth were cut in half with a thickness of more than 5 mm. The pieces were placed on an IP (20×25 cm) together with a KCl crystal for 7 days (one week) in a lead cave with a wall thickness of 50 mm, with 5mm thickness acrylic plates of 5 mm thickness on the inner surface [2]. The room where measurements were taken was kept at 24°C. A black cloth covered the lead blocks to prevent the leaking of light into the inside.

The IP was then moved to a tray in BAS-1800II (Fuji, Co.) in a dark room and the images of the ^{90}Sr distribution were obtained with pixel resolution of 0.5 mm × 0.5 mm. Using software Multi Gage v.3.0, provided by Fuji Film Co., the total PSL value (a unit in the software indicating the strength of the emitted

light) from a sample piece was summed up. After subtracting background, the value was divided by the total area of the piece measured by weighing the paper pieces which printed the images of the pieces. The PSL concentration was then normalized using the values for the standard KCl crystals (38.4Bq/g for one with a diameter of 30 mm and thickness of 10 mm and 37.1 for one with a diameter of 15 mm and thickness of 5 mm) to obtain the absolute ^{90}Sr concentrations in Bq/g in the sample. Finally, the concentration values were divided by a modification factor (MF) [4] in order to correct the sample thickness..

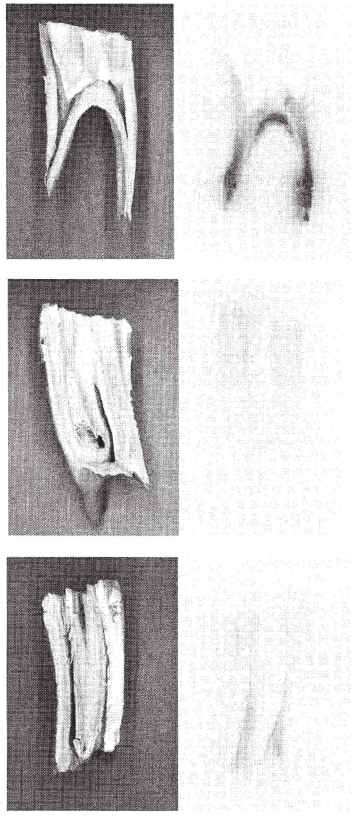

Fig. 1 Images and results of measurements on three of the present samples investigated. The vertical scale is about 8 cm. a) a domestic cow from Wintering Tulpar b) a horse from Bulak c) a horse

RESULTS AND DISCUSSIONS

Examples of obtained images are shown in Figs. 1. As ^{90}Y, an equilibrated daughter nuclei of ^{90}Sr, emits high energy β particles (maximum energy of 2.28 MeV, with a range of 4.1 mm in teeth), the image is somewhat vague and has "halo" around the image. Fig. 1a shows images for a tooth piece of a domestic cow from Wintering Tulpar, which has the highest ^{90}Sr concentration in the present samples. As no ^{137}Cs peaks were detected by a low background germanium gamma ray detector, the image represents the distribution of ^{90}Sr in the piece. Fig. 1b shows those for a tooth piece of a domestic horse from Bulak and Fig. 1c another horse. Higher concentrations were observed at boundaries between enamel and dentin as were the cases for cow teeth from South Ural [3]. Interestingly, the concentration is higher at roots than crown for the first cow and the last horse (Figs. 1a and 1c) while it is opposite for the second horse (Fig. 1b). This would be due to the difference in incorporation of ^{90}Sr into these animals as was observed in human teeth of South Ural region where it is related with the timing of ^{90}Sr incorporation and the formation of enamel and dentin [1]. However, presently it is not possible to argue such relationship because such information about feeding of these animals is not available.

Results of calculated average ^{90}Sr concentrations in the present mammal teeth are listed in Table 1. The values range from 0.4 to 13 Bq/g. Fig. 2 shows the locations of the samples with the concentrations in

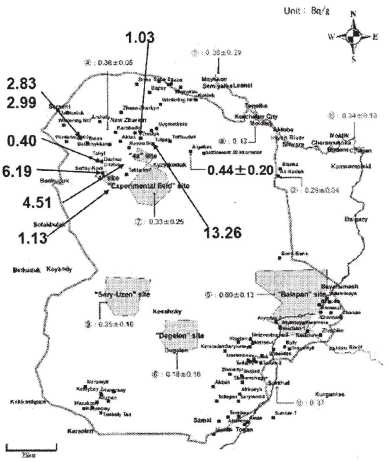

Fig. 2 Distribution of ^{90}Sr concentrations in mammal teeth obtained by IP measurements. Bold numbers shown are the present results in addition to previous ones [3].

Table 1 ^{90}Sr concentrations in mammal teeth obtained by imaging plates.

Location	Mammal	^{90}Sr (Bq/g)
Bulak	horse	2.81
		2.97
Wintering Tulpar	cow	13.2
Algabas	sheep	0.67
		0.34
Wintering Unji	cow	0.40
Dostyk	horse	4.48
	sheep	1.02
	goat	1.12
Saltay Kora	cow	6.15

addition to the values previously obtained [3]. The present values for the samples taken from north-west part of Semipalatinsk Test Site are much higher than those from other parts of Test Site and from those from outside of the Test Site. While even in Balapan, the value is lower than 1Bq/g, seven samples shows values more than 1Bq/g. These results indicate that the soil contamination level is high. We previously observed a correlation between soil contamination and ^{90}Sr in domestic cow teeth in South Ural region [3] where cows raised in the region with 100 kBq/m^2 show several Bq/g of ^{90}Sr in teeth. If this relationship is applied to the present case, the soil contamination level can be more than 100 kBq/m^2 (3 Ci/km^2). On the other hand, there are samples with values lower than 1 Bq/g. Such variability might be due to imhomogeneity of contamination. If so, we still need to be cautious about the localized contamination levels in this region.

Possible source of contamination may be the radioactive nuclei released at the time of radiological weapon tests conducted around this region to find that such weapons were not destructive, where actually spotty contamination patters have been observed [5-7]. In 20 years after the last nuclear weapon test, it would still be necessary to investigate the actual distribution of such high level of contamination before providing the land for agricultural use.

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