# 1–15 Rapid Analysis of $^{90}$Sr in Small Bone Samples

## —Applicability of Sr Resin for ICP-MS of $^{90}$Sr in Hard Tissues—

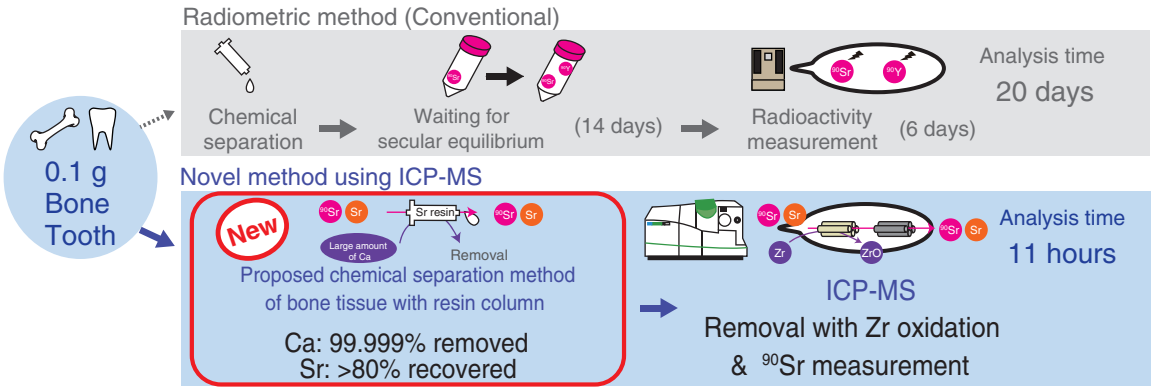


**Fig.1-33 Conventional radiometric method and proposed ICP-MS method to determine $^{90}$Sr concentration in bone and tooth samples**
The developed chemical separation method removes interfering substances, such as Ca, in bones by repeated column separation. Rapid analysis of the $^{90}$Sr concentration of bone and tooth samples was achieved by ICP-MS coupled with the developed separation techniques.

**Table 1-1 Measured $^{90}$Sr concentration in 0.1 g of cattle bone and tooth using the proposed ICP-MS and radiometric methods**
Comparable radioactivity concentrations of $^{90}$Sr in 0.1 g of hard tissues were found using the proposed and conventional radiometric methods. Further, the proposed method using ICP-MS had a lower detection limit than did the radiometric method.

| Sample | Cattle bone | | Cattle tooth | |
|---|---|---|---|---|
| Method | ICP-MS | Radiometric | ICP-MS | Radiometric |
| $^{90}$Sr concentration±SD (Bq/kg) | 700±250 | 750±65 | 210±94 | 240±24 |
| Limit of detection (Bq/kg) | 36 | 91 | 36 | 87 |

SD: Standard deviation of $^{90}$Sr concentration

Strontium-90 ($^{90}$Sr) is a typical fission product, has a half-life of 28.8 y, and has bone-seeking properties. The radioactivity concentration of $^{90}$Sr in hard tissues of mammals (e.g., bones, teeth) is positively correlated with that of plants or soils obtained from the fields where the mammals have grown. Thus, the $^{90}$Sr concentration in hard tissues can be used to clarify the $^{90}$Sr distribution in the local environment. However, the conventional $^{90}$Sr analysis method (i.e., the radiometric method) needs samples of at least 1 g and thus cannot be used to determine $^{90}$Sr in small bone, tooth, or fish otolith samples.

Recently, a $^{90}$Sr analysis method in soil and plants using inductively coupled plasma mass spectrometry (ICP-MS) has been developed that has a comparable detection limit. Although this method can be used to analyze small samples with low Ca content, such as soils and plants, the high concentration of Ca and isobar (e.g., zirconium-90; $^{90}$Zr) in hard tissues interferes with $^{90}$Sr measurements. To measure the radioactivity concentration of $^{90}$Sr in hard tissues using ICP-MS, therefore, we investigated using a resin column to remove these interfering elements.

After acid digestion of 0.1-g samples of bones and teeth, the interfering elements were removed by chemical separation using a Sr resin to selectively uptake Sr into crown ether sites. ICP-MS was then performed on the solution eluted from the resin to determine the $^{90}$Sr concentration. The recovery rate of Sr was calculated using the degree of the decrease in 11 μg of stable strontium-88 ($^{88}$Sr) in the 0.1 g samples before and after separation.

By performing column separation twice, our developed method recovered more than 80% of the Sr and removed 99.999% of the Ca. Furthermore, the proposed method provided results more rapidly than the conventional radiometric method (11 hours versus 20 days, respectively). Thus, coupling ICP-MS and our proposed separation technique allowed for the rapid analysis of $^{90}$Sr in cattle bone and tooth samples, as shown in Fig.1-33. The activity concentrations determined by ICP-MS after separation were in good agreement with those by the conventional radiometric method, as shown in Table 1-1. Further, the $^{90}$Sr detection limit using ICP-MS of 0.1 g samples was lower than that of the radioactivity measurement. Therefore, coupling the proposed separation technique with ICP-MS can be used to quantify the $^{90}$Sr concentration in small bone and tooth samples of terrestrial animals, thereby allowing researchers to track the distribution of $^{90}$Sr in animal habitats.

This work was performed in collaboration with Tohoku University as part of a project entitled, "Investigation of Sr incorporation recorded in teeth of animals related to environmental transfer".

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**Reference**

Koarai, K. et al., Rapid Analysis of $^{90}$Sr in Cattle Bone and Tooth Samples by Inductively Coupled Plasma Mass Spectrometry, Journal of Analytical Atomic Spectrometry, vol.36, issue 8, 2021, p.1678–1682.