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Comparative study of radioactivity in NORM samples using ICP-MS and Instrumental Neutron Activation Analysis

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As an attempt to reduce the social costs and apprehension arising from radioactivity in the environment, an accurate and rapid assessment of radioactivity is highly desirable. Naturally occurring radioactive materials (NORM) are widely spread throughout the environment. Concern regarding the radioactivity from these materials has therefore been growing over the last decade. To determine the proper handling options, a rapid and accurate analytical method that can be used to evaluate the radioactivity of radionuclides (e.g., 238U, 235U, 232Th, 226Ra, and 40K) should be developed and validated.

Typically, α-spectrometry has a major disadvantage of a long counting time, while it has a prominent measurement capability at a very low activity level of 238U, 235U, 232Th, and 226Ra. Contrary to the α-spectrometry method, a measurement technique using ICP-MS allows radioactivity in many samples to be measured in a short time period with a high degree of accuracy and precision. For both techniques, however, the pretreatment process consequently plays an important role in the measurement uncertainty. Thus, a method development and validation should be performed. A method was developed for a rapid analysis of natural radioactive nuclides using ICP-MS. A sample digestion process was established using LiBO2 fusion and Fe co-precipitation. A magnetic sector field ICP-MS (SPECTRO MS) was used for a rapid determination of the radionuclide concentration. For an evaluation of the accuracy and precision of the method, certified reference materials (CRMs) were analyzed using an established process. The analytical results of CRM samples were in agreement with the certified concentration values.

In this study, the radioactivity concentration in raw materials (e.g., bauxite, bentonite, ceramic, clay, monazite, and zirconium sand) and by-products (e.g., coal fly and bottom ash) was determined using ICP-MS and LiBO2 fusion method. To validate the analytical results using the method evaluated in this study, duplicate samples were also analyzed using an instrumental neutron activation analysis.

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