High Sensitivity Measurement of Iodine-129 by Accelerator Mass Spectrometry (AMS)

New Technique Has Shorter Processing Time, Higher Precision and Higher Sensitivity than Neutron Activation Analysis (NAA)

Fig.12-19  AMS at the Mutsu Establishment
This AMS consists of two ion injection lines (left), a tandem accelerator (center) and two mass analyzing lines (right). The measurement of $^{129}I$ uses the outer beam line. This beam line has a high-resolution magnet, a high-energy resolution electrostatic analyzer and a time of flight detector.

![Graph showing $^{129}I$ counts versus channel number]

Fig.12-20  $^{129}I$ spectrum detected by time of flight detector
There is no interfering peak around the $^{129}I$ peak, showing that interfering ions were removed by the analyzing magnet and electrostatic deflector.

Fig.12-21  Linearity experiment
This experiment demonstrated that this AMS has excellent linearity with nominal value between $10^{35}-10^{12}$ iodine isotopic ratio.

Iodine-129 ($^{129}I$) is a long-lived radioactive isotope with a half-life of 15.7 million years which is released from spent nuclear fuel reprocessing plants. $^{129}I$ is an important nuclide for monitoring around nuclear facilities and also useful for tracing in hydrogeologic and oceanographic research. NAA is recommended as a measurement technique for $^{129}I$ in the “Analytical method of radioactive iodine-129” published by the Ministry of Education, Culture, Sports, Science and Technology of Japan. Because NAA has a high detection limit ($^{129}I/^{127}I = 10^{-4}$-$10^{-5}$), it takes much time for analysis, has low precision, and would cause radiation exposure during analysis, it is not suitable for environmental samples ($^{129}I/^{127}I = 10^{-15}$-$10^{-16}$) except for the monitoring around nuclear facilities. Therefore, a measurement technique for $^{129}I$ with short processing time, high precision and high-sensitivity was developed using accelerator mass spectroscopy (AMS) (Fig. 12-19) set up at Mutsu establishment.

In mass analyzing for $^{129}I$ (m/e=25.8), $^{103}$Rhodium$^+$ (m/e=25.75) and $^{59}$Chromium$^+$ (m/e= 26.0) interfere with analysis because the mass to charge ratio is close. We succeeded in removing the interfering ions by the improvement of the mass resolution using a high mass resolution magnet, high energy resolution electrostatic deflector and time of flight detector (Fig.12-20). Also, a stable beam from the target is obtained by mixing sufficient Niobium in the target to increase conductivity, resulting in reliable measurement.

Standard samples which had a variety of iodine isotopic ratios between $10^{10}$ and $10^{12}$ were measured for about 60 min and the excellent linearity of the plot of nominal and measured values (Fig.12-21) shows that this AMS has good precision. Evaluating the detection limit of this method using commercial silver iodide, it was possible to measure as low as a $10^{14}$ iodine isotopic ratio.

This measurement technique enables not only the simplification of the monitoring around the nuclear facilities but also breakthrough use of $^{129}I$ in environmental migration research.

Reference