SHIMADZU
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Application News

No.J118

Inductively Coupled Plasma Mass Spectrometry

Analysis of River Water by ICPMS-2030

Introduction

The normal daily water consumption of adults is thought to be around 2 liters, almost all of which consist of drinking water such as tap water or mineral water. Sources of this drinking water include river water and ground water. Each country has regulations that require testing of the safety and condition of river water and ground water. Countries also stipulate environmental standards for the protection of our living environment that also require testing. These include tests for high concentration elements such as sodium and calcium that are present at 10 mg/L or higher, and trace elements such as arsenic and lead that are present at 10 µg/L or lower. We describe using Shimadzu's ICPMS-2030 inductively coupled plasma mass spectrometer to analyze river water for the presence of these elements.

Sample

- River water reference material: JSAC 0301-3, 0302-3

Instrument

Shimadzu's ICPMS-2030 inductively coupled plasma mass spectrometer was used for analysis. In addition to being highly sensitive, the ICPMS-2030 uses a helium gas collision system that greatly reduces the spectral interference caused by argon and chlorine. Use of Eco mode and a mini-torch drastically reduces running costs associated with gas usage, compared to previous ICP-MS systems.

Analysis

A calibration curve method was used to measure trace amounts of 19 constituents: lead (Pb), chromium (Cr), cadmium (Cd), selenium (Se), arsenic (As), copper (Cu), Iron (Fe), manganese (Mn), zinc (Zn), boron (B), aluminum (Al), nickel (Ni), barium (Ba), molybdenum (Mo), uranium (U), potassium (K), sodium (Na), magnesium (Mg), and calcium (Ca).

Internal reference standard elements (Co, Ga, Y, In, Tl) were added to each sample to a concentration of 5 µg/L. Since this study examines a tap water source, analysis was performed based on the ministerial ordinance on water quality standards issued by the Ministry of Health, Labour and Welfare.

Removal of Spectral Interference (Collision System)

The sensitivity of ICP-MS is reduced by spectral interferences arising from polyatomic ions and errors in results are found. For water quality analysis, these polyatomic ions include $^{40}Ar^{16}O$ that interferes with measurement of ^{56}Fe, $^{40}Ar^{35}Cl$ that interferes with measurement of ^{75}As, and $^{40}Ar^{38}Ar$ that interferes with measurement of ^{78}Se.
Fig. 1 and 2 show the calibration curves for Fe and Se without using the collision system (No-Gas mode) and while using the collision system (CC mode). The collision system removes spectral interference, which increases the detection limit.

Analytical Results

Table 1 shows Japan's drinking water quality standards and results obtained from analysis of river water reference material. Good quantitative results were obtained that matched the certified values, even when analyzing trace concentrations that were below reference values.

[References]
- Ministerial ordinance on water quality standards (Ministry of Health, Labour and Welfare ordinance No. 101, May 30, 2003; Revised by Ministry of Health, Labour and Welfare ordinance No. 15, February 28, 2014) [In Japanese]
- Methods determined by Minister of Health, Labour and Welfare based on regulations of the ministerial ordinance on water quality standards (Ministry of Health, Labour and Welfare notification No. 261, July 22, 2003; Revised by Ministry of Health, Labour and Welfare notification No. 56, March 12, 2015) [In Japanese]

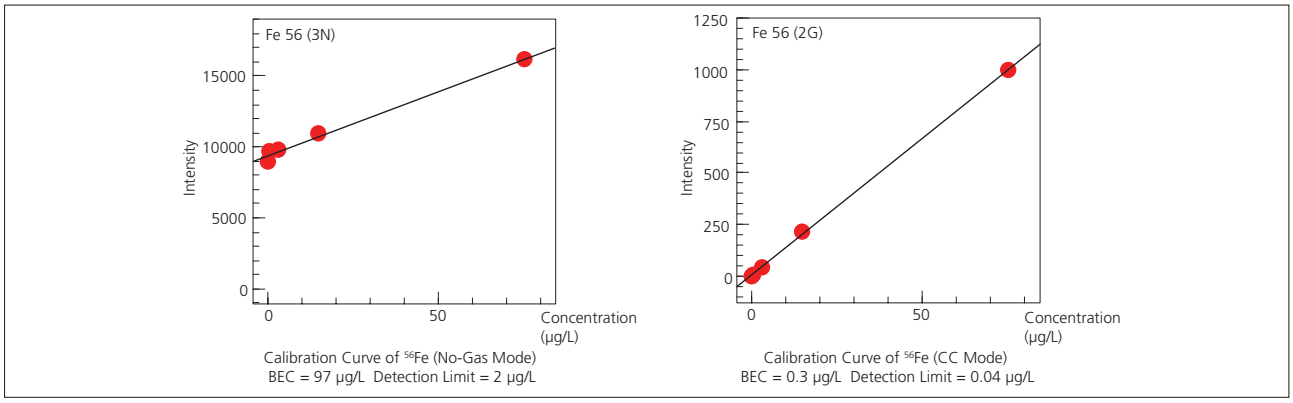

Fig. 1 ^{56}Fe Calibration Curves

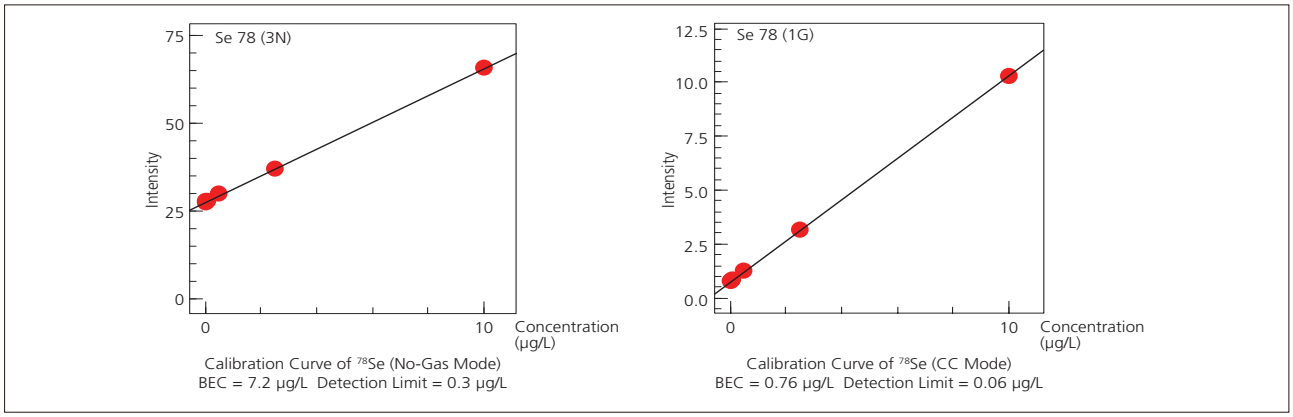

Fig. 2 ^{78}Se Calibration Curves

Table 1 Quantitative River Water Results

Element	Water Quality Standards, Water Supply Act	Sample: JSAC 0301-3				Sample: JSAC 0302-3			
		Quantitation Value	Certified Value			Quantitation Value	Certified Value		
Units (µg/L)									
Al	200	15.2	15	±	1	66.9	66	±	1
As	10	0.21	0.20	±	0.01	5.27	5.2	±	0.1
B	1000	8.3	8.2	±	0.3	58.4	59	±	1
Ba	700**	0.52	0.53	±	0.01	0.52	0.52	±	0.01
Cd	3	0.0018	0.0018 (Reference value)			1.01	1.00	±	0.02
Cr	50	0.17	0.16	±	0.01	10.0	10.0	±	0.2
Cu	1000	0.38	0.37	±	0.03	10.0	9.9	±	0.1
Fe	300	6.2	6.4	±	0.2	58.7	58	±	1
Mn	50	0.20	0.20	±	0.01	5.0	5.1	±	0.1
Mo	70**	0.286	0.290	±	0.004	0.286	0.290	±	0.004
Ni	10*					9.65	9.5	±	0.3
Pb	10	0.007	0.007 (Reference value)			10.0	9.9	±	0.2
Se	10	0.04	0.08 (Reference value)			5.0	5.0	±	0.2
Zn	1000	0.16	0.17	±	0.04	9.7	9.8	±	0.2
U	2	0.0030	0.0030	±	0.0001	0.0032	0.0031	±	0.0001
Units (mg/L)									
K		0.47	0.47	±	0.02	0.48	0.48	±	0.02
Na	200	4.32	4.34	±	0.07	4.31	4.32	±	0.07
Mg	Hardness: 300	3.34	3.34	±	0.07	3.36	3.32	±	0.06
Ca		13.0	13.0	±	0.2	13.0	13.0	±	0.1

*: Water quality target **: Water quality consideration

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