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Neutron Activation Analysis of Japanese Standard Rock Samples III

By

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Abstract

Non-destructive instrumental neutron activation analysis was carried out for determining four major and twelve trace elements in six new Japanese standards rock samples, JSd-1, JSd-2, JSd-3, JSl-1, JSl-2 and JCh-1, which were issued as a part of "sedimentary rock series" from the Geological Survey of Japan (GSJ) in 1988 and 1989.

1. Introduction

In previous reports (WAKABAYASHI, 1987 and 1988), nondestructive instrumental neutron activation analyses were carried out for eighteen Japanese geological standard rock samples (that is, fifteen "igneous rock series" samples and three "sedimentary rock series" samples) which were issued from the Geological Survey of Japan (GSJ) before 1987.

Six new "Sedimentary rock series" standards rocks, JSd-1, JSd-2, JSd-3, JSl-1, JSl-2 and JCh-1 were issued from GSJ in 1988 and 1989 (TERASHIMA *et al.*, 1989).

In this report, nondestructive instrumental neutron activation analysis results of these new sedimentary rock samples are reported.

2. Experimental

The experimental procedures are similar to those described before (WAKABAYASHI, 1987 and 1988). A brief explanation is made below.

Each samples was weighed accurately (about 10 mg) and irradiated for 10 minutes in JRR-4 reactor at a flux of 8×10^{13} neutrons/cm^2·sec in the Japan Atomic Energy Research Institute (JAERI) at Tokai. Irradiated samples were cooled about 20 hours, and then produced γ-ray activities were measured by a Ge (Li) γ-ray spectrometer without any chemical treatment. For long-lived nuclides, measurements of γ-activities were carried out for several times at the intervals of 3 or more weeks.

JB-1, JG-1 and W-1 were used as standards, as well as Cr and Th solution standards in a similar way described before. The best values used as standards were summarized in the previous reports. These values were those compiled in 1986 for JB-1

Table 1. 1988 consensus values for JB-1 and JG-1 using as the standards in this work.

Element	JB-1	JG-1	Element	JB-1	JG-1
Major elements (%)					
Fe	6.27	1.50	K	1.19	3.30
Na	2.07	2.51	Mn	0.12	0.049
Trace elements (ppm)					
Ce	67	46.6	La	38	23
Co	38.7	4.0	Lu	0.31	0.46
Cs	1.19	10.2	Sc	27.4	6.5
Eu	1.52	0.76	Sm	5.0	5.1
Ga	18.1	17	Th	9.2	13.5
Hf	3.4	3.5	Zn	83	41.5

A. ANDO *et al.*, *Geochem. J.*, **23**, 143 (1989).

and JG-1 (ANDO *et al.*, 1987), and in 1972 for W-1 (FLANAGAN, 1973). As for JB-1 and JG-1, new data (1988 consensus values) were published recently (ANDO *et al.*, 1989). Most of the values were not changed from those summarized in the previous reports. But in this work, JG-1 was used as standards for elements which were not mentioned in the previous reports. So newly published 1988 consensus values for JB-1 and JG-1 used as standards in this work are summarized in Table 1. Values for W-1 are the same as those summerized before.

3. Results

Results are tabulated in Tables 2 and 3. Each values in the tables was obtained through averaging at least three data which had been measured from time to time. The quoted errors in the tables are the standard deviations.

Three samples of JSd-2 and JSl-2 were taken from the samples with same split and position numbers, respectively. Two of these three samples were irradiated at the same time, and the another was irradiated at different time. As for JSd-1 and JSl-1, two samples were taken from the samples with same split and position numbers, and irradiated at different time. All these results were averaged and are tabulated here.

On the other hand, JSd-1 and JSl-1 samples with different split and position numbers were irradiated and analyzed at the same time with this work. These results will be reported elsewhere.

Value for Cs of JSd-2 is not listed in Table 1 because of the big discrepancy between the analytical results derived from 604.5 keV γ-ray peak and 795.9 kev peak of ^{134}Cs; 604.5 keV peak gave the result 6.1 ± 0.1 ppm, and 795.9 keV peak gave 1.19 ± 0.08 ppm. And these values are changing with time to time. This discrepancy can be attributed to unknown impurity nuclides whose γ-ray peaks are positioned at very similar energy region with ^{134}Cs's Peaks. Extended measurements are required to confirm this explanation and to derive correct value.

Table 2. Results of neutron activation analysis of standard rock samples JSd-1, JSd-2, and JSd-3

Element	JSd-1	JSd-2	JSd-2
	This work	This work	This work
Major elements (%)			
Fe	3.69 ±0.03	8.68 ± 0.04	3.35 ±0.04
Na	1.73 ±0.01	1.87 ± 0.01	0.369±0.001
K	1.84 ±0.03	0.98 ± 0.02	1.89 ±0.03
Mn	0.079±0.002	0.103± 0.002	0.131±0.003
Trace elements (ppm)			
Ce	34.9 ±0.9	30.2 ± 0.6	50.6 ±1.7
Co	11.5 ±0.2	53.2 ± 0.4	14.0 ±0.3
Cs	2.11 ±0.07	—	28.4 ±0.7
Eu	1.06 ±0.02	1.09 ± 0.01	0.90 ±0.02
Ga	19.6 ±2.0	15.0 ± 1.3	13.2 ±1.6
Hf	2.74 ±0.08	1.97 ± 0.06	3.3 ±0.2
La	17.4 ±0.8	13.9 ± 0.5	23.7 ±0.9
Lu	0.24 ±0.03	0.26 ± 0.03	0.23 ±0.03
Sc	10.9 ±0.1	19.6 ± 0.1	11.8 ±0.1
Sm	4.2 ±0.3	3.1 ± 0.2	3.9 ±0.3
Th	4.3 ±0.2	5.0 ± 0.1	6.2 ±0.2
Zn	75 ±4	1206 ±39	87 ±6

JSd-1 Stream sediment. Stream sediment (Arkose sandstone), Irishiken river, Hitachi, Ibaraki Prefecture.
split 2, position 58.

JSd-2 Stream sediment. East side of Ibaraki Prefecture.
split 5, position 16.

JSd-3 Stream sediment. Stream sediment near Takatori Mine (tungsten), Katsuramura, Ibaraki Prefecture.
split 9, position 48.

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Table 3. Results of neutron activation analysis of standard rock samples JSl-1, JSl-2, and JCh-1

Element	JSl-1 This work	JSl-2 This work	JCh-1 This work
Major elements (%)			
Fe	4.76 ±0.03	4.59 ±0.03	0.274 ±0.004
Na	1.68 ±0.01	0.992 ±0.001	0 0419±0.0002
K	2.46 ±0.03	2.42 ±0.02	0.220 ±0.004
Mn	0.051±0.002	0.0688±0 0010	0 018 ±0.006
Trace elements (ppm)			
Ce	58.4 ±1.2	65.6 ±1.0	5.58 ±0.18
Co	16.2 ±0.2	16.0 ±0.1	17.0 ±0 2
Cs	7.8 ±0.2	8.7 ±0.1	0 30 ±0.02
Eu	1.33 ±0.02	1.29 ±0 01	0.076 ±0 02
Ga	18.4 ±1.4	16.7 ±1.1	1.5 ±0 2
Hf	3.37 ±0.10	3.53 ±0 07	0 25 ±0 02
La	29.0 ±0.6	32.0 ±0.5	1 9 ±0.1
Lu	0.40 ±0.03	0.36 ±0.02	0.028 ±0.002
Sc	16.8 ±0.1	16.9 ±0.1	1.03 ±0.01
Sm	6.3 ±0.3	6.5 ±0.2	0.42 ±0.04
Th	8.5 ±0.2	10.0 ±0 2	0.49 ±0.02
Zn	84 ±4	83 ±3	7.1 ±0.6

JSl-1 Slate. Toyama slate, Permian, Toyama-machi, Miyagi Prefecture. split 4, position 81.

JSl-2 Slate. Toyama slate, Permian, Ogatsu-cho, Miyagi Prefecture. split 2, position 92.

JCh-1 Chert. Ashio chart, Permian to middle Mesozoic, Ashikaga, Tochigi Prefecture. split 2, position 5.

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