

## 1987 compilation of K<sub>2</sub>O concentrations in seventeen GSJ rock reference samples, "Igneous rock series"

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ANDO, A., MITA, N. and MATSUMOTO, A. (1989) 1987 compilation of K<sub>2</sub>O concentrations in seventeen GSJ rock reference samples, "Igneous rock series". *Bull. Geol. Surv. Japan*, vol. 40(1), p. 19-45.

**Abstract** : K<sub>2</sub>O data received by December 1987 on seventeen GSJ rock reference samples, "Igneous rock series" have been compiled.

Based on the data available (published and communicated), means (All), medians, standard deviations (S. D.), concensus means ( $\pm 2$  S. D. and  $\pm 1$  S. D.) and histograms have been derived. Significant difference has not been observed between the values obtained by the different analytical methods (FE, AA, XRF etc.) for most of the GSJ samples.

However, for a low K<sub>2</sub>O concentration sample (JP-1) and high K<sub>2</sub>O concentration samples (JF-1 and JF-2), significant difference has been observed between the values obtained by XRF and by other methods (AA, NAA). Recommendable 1987 K<sub>2</sub>O concentrations for seventeen GSJ rock reference samples have been given after evaluation of the above statistical results.

### Introduction

The Geological Survey of Japan (GSJ) has been processing a series of rock reference samples for major, minor and trace elements, isotopic compositions and geological ages.

Two rock reference samples GSJ JG-1 granodiorite and JB-1 basalt, were issued in 1967 and 1968 (ANDO, 1967 ; KURASAWA, 1968) respectively. Comprehensive compilations of data for these rocks have been previously reported concerning chemical and isotopic composition, and geological ages (ANDO *et al.*, 1981 ; ANDO *et al.*, 1984). Best values for JG-1 and JB-1 have also been proposed (FLANAGAN, 1983). Statistical evaluation of Rb, Sr, K and Na concentrations has been reported by

ANDO *et al.* (1985). However, supply of these samples was exhausted in 1981, after the analytical data for 75 components were mostly settled (ANDO, 1984a ; ANDO, 1984b).

Preparation of the second series of GSJ rock reference samples, "Igneous rock series", was started in April 1981 and was completed in March 1986. Fifteen new rock reference samples are added to the list of GSJ analytical program of rock reference samples. 1986 values for major and minor elements, for this second series of samples as well as for the first series of two samples JG-1 and JB-1, have been reported (ANDO *et al.*, 1987).

An accurate analysis of potassium concentrations in rocks and minerals is required for K-Ar age determination. The error associated with the potassium analysis in the dating laboratory of the Geological Survey of Japan is estimated to

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Table 1 GSJ rock reference sample, "Igneous rock series".

Name	Rock	Issued Year	Note	Latitude	Longitude
JG-1	Granodiorite	(1967)	Sori granodiorite (Biotite granodiorite), 85 Ma, Azuma-mura, Gunma Prefecture.	36° 34' 13" N	139° 23' 30" E
JG-1a	Granodiorite	(1984)	Replacement sample of JG-1.		
JG-2	Granite	(1985)	Naegi granite (Biotite granite), Cretaceous, Hirukawa-mura, Gifu Prefecture.	35° 29' 22" N	137° 24' 65" E
JG-3	Granodiorite	(1986)	Mitoya granodiorite (Hornblende-biotite granodiorite), Cretaceous-Paleogene, Mitoya-cho, Shimane Prefecture.	35° 16' 41" N	132° 52' 19" E
JR-1	Rhyolite	(1982)	Wada Toge obsidian, 0.8 Ma, north of Wada Toge, Wada-mura, Nagano Prefecture.	36° 09' 04" N	138° 08' 43" E
JR-2	Rhyolite	(1983)	Wada Toge obsidian, south of Wada Toge, Shimosuwa-machi, Nagano Prefecture.	36° 08' 08" N	138° 08' 36" E
JA-1	Andesite	(1982)	Hakone volcano, Old Somma lava (Augite-hypersthene andesite), Quaternary, Manazuru-machi, Kanagawa Prefecture.	35° 09' 44" N	139° 08' 04" E
JA-2	Andesite	(1985)	Goshikidai sanukitoid (Olivine andesite), 13 Ma, Sakaide, Kagawa Prefecture.	34° 18' 30" N	133° 55' 37" E
JA-3	Andesite	(1986)	Asama volcano (Olivine-bearing augite-hypersthene andesite) erupted in 1783, Oni-Oshidashi, Tsumagoi-mura, Gunma Prefecture.	36° 26' 25" N	138° 31' 85" E
JB-1	Basalt	(1968)	Kitamatsuura basalt (Alkali basalt, Titanaugite-olivine basalt), 7.6 Ma, Myokanji Toge, Sasebo, Nagasaki Prefecture.	33° 13' 58" N	129° 41' 41" E
JB-1a	Basalt	(1984)	Replacement sample of JB-1.		
JB-2	Basalt	(1982)	Ō-shima volcano (Tholeiitic basalt, Augite-bronzite basalt) erupted in 1950-1951, northern rim of Mihara crater, Ō-shima, Tokyo.	34° 43' 41" N	139° 23' 46" E
JB-3	Basalt	(1983)	Fuji volcano (High alumina basalt, Hypersthene-augite-olivine basalt) erupted in 864, Aokigahara lava flow, Narusawa-mura, Yamanashi Prefecture.	35° 28' 31" N	138° 41' 58" E
JGb-1	Gabbro	(1983)	Utsushigatake (Augite-hypersthene hornblende gabbro), 86 Ma, Funehikimachi, Fukushima Prefecture.	37° 28' 53" N	140° 36' 48" E
JP-1	Peridotite	(1984)	Horoman peridotite (Dunite). Horoman, Hokkaido.	42° 04' 43" N	143° 02' 31" E
JF-1	Feldspar	(1985)	Ō-hira feldspar (Mixture of orthoclase and albite), Nagiso-machi, Nagano Prefecture.	35° 33' 37" N	137° 40' 16" E
JF-2	Feldspar	(1986)	Kurosaka feldspar (Orthoclase), Kurosaka, Ibaraki Prefecture.	36° 41' 33" N	140° 32' 36" E

be 2% (C. V.), based on the results of 64 analysis of JG-1 sample by atomic absorption spectrometry (UCHIUMI and SHIBATA, 1980). To assure the accuracy and the precision of the potassium analysis for various types of rock samples, establishment of recommendable values of potassium for all GSJ rock reference samples is desirable.

1986 values for major elements were mainly derived from results obtained by total rock analysis, conventional wet chemical methods along with atomic absorption spectrometry for potassium and sodium. Statistical analysis for all data has not been done. In this paper, all reported data for potassium (total  $n=589$ ) obtained by various (12) analytical methods, received by December 1987, are tabulated.

Potassium concentration for each sample was statistically examined in detail. Recommended values for seventeen GSJ rock reference samples, "Igneous rock series", are given by the evaluation of all statistical results.

#### Note on the GSJ rock reference samples

Brief description of seventeen GSJ rock reference samples including sampling location is presented in Table 1. K-Ar ages mentioned in Table 1 are cited from following literatures: JG-1 (SHIBATA, 1968), JR-1 (SHIBATA and UCHIUMI, 1983), JA-2 (SATO, 1982), JB-1 (SHIBATA and UCHIUMI, 1985) and JGb-1 (FUKAZAWA and ONUKI, 1972). JG-1a and JB-1a are replacement samples respectively of JG-1 and JB-1. JB-1a was prepared from the same stock chips as JB-1. However, we had insufficient amount of stock chips of JG-1 for its reparation, hence resampling of JG-1a was done for the same quarry as of JG-1, although the sampling-point was not identical.

#### Statistical evaluation of the results

Based on the data available (published and communicated), mean, median, standard deviation (S. D.), consensus means ( $\pm 2$  S. D. and  $\pm 1$  S. D.) and coefficient of variation (C. V.) have been calculated for each sample and for each analytical method (Table A-1). Code for analytical methods is given in footnote of Table A-2. Histograms for seventeen samples have also been presented (Fig. 1). All reported data are tabulated in Table A-2 (with references for individual data).

Potassium concentrations and analytical errors for nine USGS rock reference samples, in collaborative analyses, have been reported by GLADNEY *et al.*, 1983 (Table 2). Potassium ( $K_2O$ ) were determined with errors of 2.5-4.7 C. V.% for most of the samples ( $K_2O$ : 1.7-5.5%), 6.4 C. V.% for W-1 ( $K_2O$ : 0.64%), 40 and 100 C. V.% for PCC-1 and DTS-1 ( $K_2O$ : 0.005 and 0.001%), respectively. Potassium ( $K_2O$ ) concentrations for GSJ rock reference samples, "Igneous rock series" were also determined with errors of 1.4-7.2 C. V.% for most of the samples ( $K_2O$ : 0.42-13.1%), 11 C. V.% for JGb-1 ( $K_2O$ : 0.24%), 80 C. V.% for JP-1 ( $K_2O$ : 0.03%). Analytical errors are substantially increased toward low potassium concentration region (Fig. 2), as same as USGS samples.

Significant difference has not been observed between the potassium concentrations obtained by the different analytical methods (FE, AA, XRF etc.) for most of the GSJ samples. However, for JP-1, sample of low potassium concentration, significant difference has been observed between the values obtained by XRF and by other methods (see Table A-1 and Fig. 1). XRF method gives higher results than other methods owing to the measurement

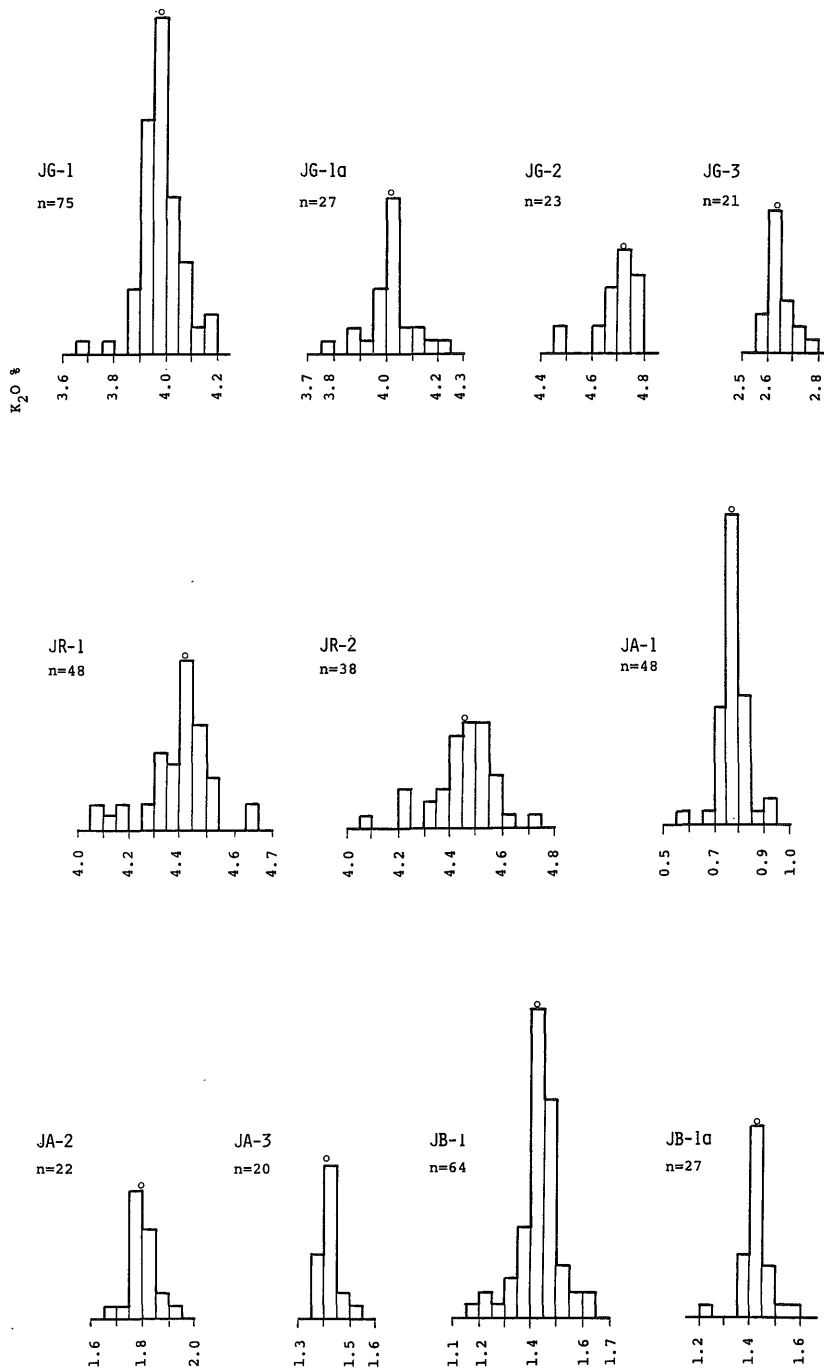


Fig. 1 Histograms. Abbreviations for Fig. 1 —Analytical methods— A: AA (Atomic absorption spectrometry), F: FE (Flame emission spectrometry), N: NAA (Neutron activation analysis), X: XRF (X-ray fluorescence spectrometry),  $\gamma$ :  $\gamma$  cntg. ( $\gamma$ -ray counting), U: Unreported.

○Mark indicates the position for 1987 value.

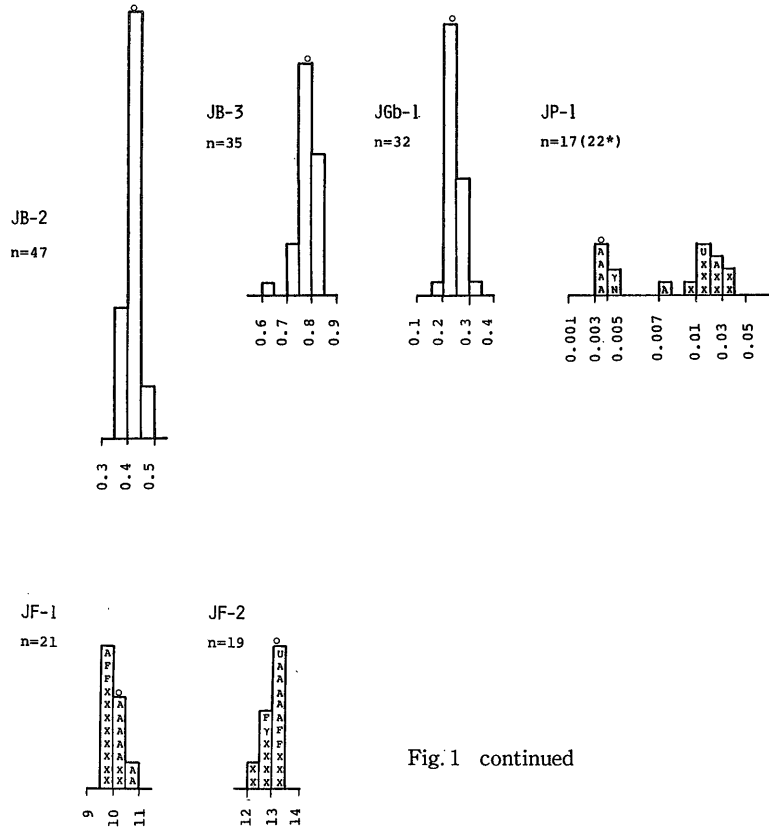


Fig. 1 continued

Table 2 Potassium concentrations for USGS rock reference samples.

	Rock	$K_2O$ mean* $\pm$ 1 S. D.	C. V. %
AGV-1	Andesite	$2.90 \pm 0.10$	3.45
BCR-1	Basalt	$1.69 \pm 0.08$	4.73
DTS-1	Dunite	$0.001 \pm 0.001$	100
G-1	Granite	$5.48 \pm 0.14$	2.56
G-2	Granite	$4.49 \pm 0.14$	3.12
GSP-1	Granodiorite	$5.51 \pm 0.14$	2.54
PCC-1	Peridotite	$0.005 \pm 0.002$	40.0
W-1	Diabase	$0.639 \pm 0.041$	6.42

\*Mean for all reported values.

1982 consensus values (GLADNEY et al., 1983).

at the detection limit region. For high potassium concentration samples JF-1 and JF-2, significant difference has also been observed between the values obtained by XRF and by other methods. XRF

method tends to give lower results than other methods. This might be caused by the lack of good reference samples with high potassium concentrations.

Recommended 1987  $K_2O$  concentrations

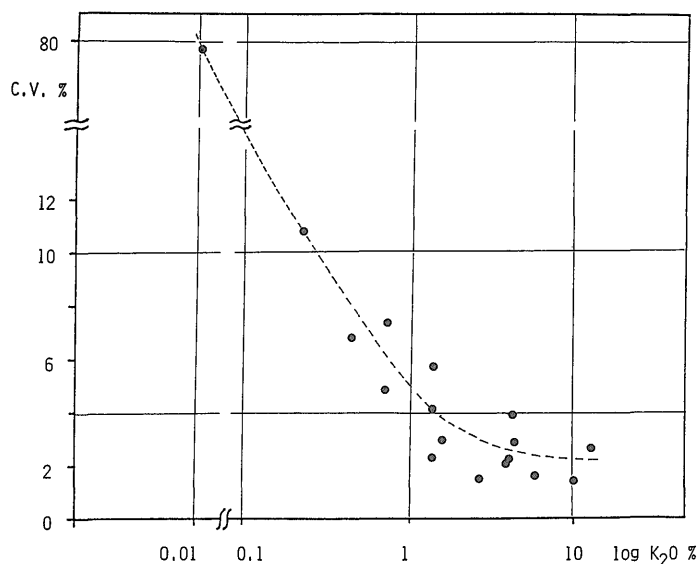


Fig. 2 Analytical errors versus potassium concentrations for GSJ rock reference samples.

for seventeen GSJ rock reference samples, "Igneous rock series" have been given in Table 3. Means ( $\pm 2$  S. D.) were adopted as recommended values for the most samples. Means ( $\pm 1$  S. D.) were also adopted as recommended value for some samples, when the C. V. % value of mean ( $\pm 2$  S. D.) was over 5%.

Comments on deriving recommended values are given in Table 3.

Percentages of analytical methods applied to potassium determination in collaborative analyses, are shown in Fig. 3. In more recent analyses, percentage of XRF is substantially increased, on the contrary FE is sharply decreased and AA is not changed, compared with those of older analyses (JG-1 and JB-1).

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Table 3 1987 K<sub>2</sub>O values for GSJ rock reference samples, "Igneous rock series".

	K <sub>2</sub> O % ±	S.D.	Note	Ref. value %
JG-1	3.97 ±	0.058	Mean(± 2 S.D.): 3.971, Mean(± 1 S.D.): 3.970	3.95
JG-1a	4.01 ±	0.068	Mean(All): 4.010, Mean(± 2 S.D.): 4.010, Mean(± 1 S.D.): 4.011	4.04
JG-2	4.72 ±	0.048	Mean(± 2 S.D.): 4.715, Median: 4.72	4.76
JG-3	2.63 ±	0.039	Mean(± 2 S.D.): 2.633; Median: 2.63	2.63
JR-1	4.41 ±	0.112	Mean(± 2 S.D.): 4.405; Median: 4.41	4.40
JR-2	4.45 ±	0.103	Mean(± 2 S.D.): 4.451, Median: 4.45	4.48
JA-1	0.775 ±	0.037	Mean(± 2 S.D.): 0.775 is taken.	0.82
JA-2	1.80 ±	0.040	Mean(± 2 S.D.): 1.798, Median: 1.80	1.78
JA-3	1.41 ±	0.026	Mean(± 2 S.D.): 1.414, Mean(± 1 S.D.): 1.414, Median: 1.41	1.43
JB-1	1.43 ±	0.051	Mean(± 2 S.D.): 1.432, Mean(± 1 S.D.): 1.430, Median: 1.43	1.42
JB-1a	1.42 ±	0.033	Mean(± 2 S.D.): 1.416 is taken.	1.46
JB-2	0.418 ±	0.013	Mean(± 1 S.D.): 0.418, Median: 0.42	0.43
JB-3	0.778 ±	0.028	Mean(± 2 S.D.): 0.778, Median: 0.78	0.80
JGb-1	0.240 ±	0.012	Mean(± 1 S.D.): 0.240, Median: 0.24	0.26
JP-1	0.0033 ±	0.00057	Mean of selected five values(AA: 4 & NAA: 1)	0.003
JF-1	10.07 ±	0.022	AA Mean(± 2 S.D.): 10.074 is taken.	10.05
JF-2	13.11 ±	0.087	AA Mean(± 2 S.D.): 13.112 is taken	13.10

Ref. value (ANDO, et al., 1987)

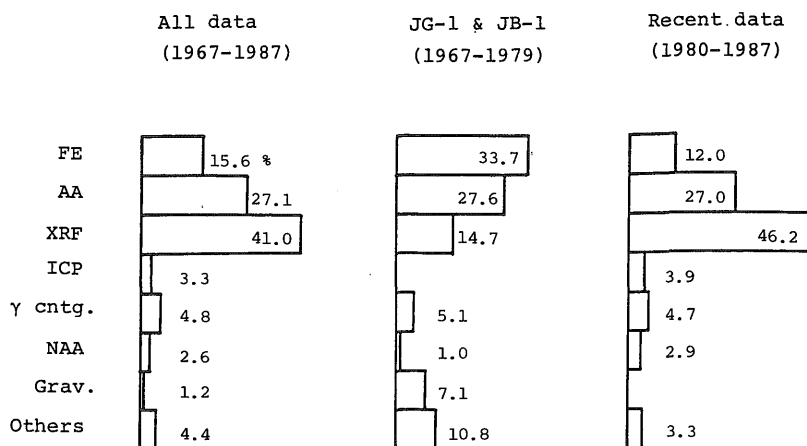


Fig. 3 Percentage of analytical method applied for potassium analysis, in collaborative analytical program, for GSJ rock reference samples.

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## 地質調査所 (GSJ) 発行の岩石標準試料“火成岩シリーズ”, 17 試料中の $K_2O$ 含有量(1987)

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### 要 旨

地質調査所発行の岩石標準試料“火成岩シリーズ”, 17 試料について, 1987 年 12 月迄に報告を受けた  $K_2O$  の定量結果 (総数 584) について統計的な考察を行い,  $K_2O$  1987 値を提示した。

各試料毎に, 平均値 (全定量結果), 中央値, 平均値 ( $\pm 2$  S. D. 及び  $\pm 1$  S. D.), 変動係数 (C. V. %) 及びヒストグラムを例示した。分析方法別にも同様な諸元の考察を行った。以下に述べる 3 試料を除く, 大多数の各試料においては分析方法別定量結果の平均値間に有意の差は認められなかった。 $K_2O$  含有量の著しく低い JP-1 (ダナイト,  $K_2O$ : 0.003%) の場合は, 蛍光 X 線分析法による定量結果は他法による定量結果に比し, 有意な高めの傾向を示した。また,  $K_2O$  含有量の高い JF-1 及び JF-2 (長石,  $K_2O$ : 10 及び 13%) の場合は, 蛍光 X 線分析法による定量結果は他法による定量結果に比し, 有意な低めの傾向が観察された。

上記の統計的な考察結果をふまえ,  $K_2O$  1987 値として, 大多数の試料については平均値 ( $\pm 2$  S. D.) (全定量結果) を, また, 平均値 ( $\pm 2$  S. D.) の変動係数 (C. V.) 値が 5 % を越える場合は, 平均値 ( $\pm 1$  S. D.) を採用した。JP-1 については原子吸光分析法と放射化分析法, JF-1 及び JF-2 については原子吸光分析法による定量結果の平均値 ( $\pm 2$  S. D.) を採用した。

(受付: 1988 年 6 月 6 日; 受理: 1988 年 7 月 28 日)



## Appendix

Table A-1 Mean, median and analytical errors on potassium concentrations for GSJ rock reference samples, "Igneous rock series".

			K <sub>2</sub> O %	±	S.D.	(n)	Median	Range	C.V. %
JG-1	Overall	Mean (All)	3.973	±	0.081	(75)		3.67 - 4.18	2.06
		Mean (± 2 S.D.)	3.971	±	0.058	(70)	3.96	3.86 - 4.11	1.46
		Mean (± 1 S.D.)	3.970	±	0.043	(60)		3.90 - 4.05	1.08
	FE	Mean (all)	3.971	±	0.108	(23)		3.67 - 4.17	2.72
		Mean (± 2 S.D.)	3.985	±	0.088	(22)	3.96	3.76 - 4.17	2.21
		Mean (± 1 S.D.)	3.967	±	0.046	(17)		3.88 - 4.05	1.16
	AA	Mean (All)	3.970	±	0.066	(18)		3.87 - 4.18	1.66
		Mean (± 2 S.D.)	3.958	±	0.041	(17)	3.96	3.87 - 4.02	1.04
		Mean (± 1 S.D.)	3.967	±	0.033	(15)		3.91 - 4.02	0.83
	XRF	Mean (All)	3.970	±	0.055	(13)		3.86 - 4.05	1.39
		Mean (± 2 S.D.)	3.969	±	0.055	(13)	3.98	3.86 - 4.05	1.39
		Mean (± 1 S.D.)	3.979	±	0.016	(8)		3.95 - 4.00	0.40
	EPMA	Mean (All)	3.925			(2)		3.92 - 3.93	
	OS (DR)		3.95			(1)			
	ICP	Mean (All)	3.998	±	0.075	(4)		3.90 - 4.08	1.88
		Mean (± 2 S.D.)	3.998	±	0.075	(4)	4.01	3.90 - 4.08	1.88
		Mean (± 1 S.D.)	4.005			(2)		3.99 - 4.02	
	Y cntg.	Mean (All)	3.987	±	0.051	(6)		3.92 - 4.05	1.28
		Mean (± 2 S.D.)	3.987	±	0.051	(6)	3.99	3.92 - 4.05	1.28
		Mean (± 1 S.D.)	3.988	±	0.039	(4)		3.95 - 4.03	0.98
	IDMS		4.05			(1)			
Grav.	Mean (All)	3.910	±	0.041	(5)		3.86 - 3.96	1.05	
	Mean (± 2 S.D.)	3.910	±	0.041	(5)	3.91	3.86 - 3.96	1.05	
	Mean (± 1 S.D.)	3.910	±	0.030	(3)		3.88 - 3.94	0.77	
Others	Mean (All)	4.115			(2)		4.06 - 4.17		
JG-1a	Overall	Mean (All)	4.010	±	0.089	(27)		3.79 - 4.23	2.22
		Mean (± 2 S.D.)	4.010	±	0.068	(25)	4.01	3.88 - 4.16	1.70
		Mean (± 1 S.D.)	4.011	±	0.038	(19)		3.95 - 4.08	0.95
	FE	Mean (All)	4.005			(2)		3.98 - 4.03	
	AA	Mean (All)	3.985	±	0.084	(8)		3.79 - 4.05	2.11
		Mean (± 2 S.D.)	4.013	±	0.033	(7)	4.02	3.96 - 4.05	0.82
		Mean (± 1 S.D.)	4.013	±	0.033	(7)		3.96 - 4.05	0.82
	XRF	Mean (All)	4.021	±	0.099	(13)		3.88 - 4.23	2.46
		Mean (± 2 S.D.)	4.003	±	0.079	(12)	4.00	3.88 - 4.16	1.98
		Mean (± 1 S.D.)	4.001	±	0.049	(8)		3.95 - 4.10	1.15

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	γ cntg.	Mean (All)	3.995		(2)		3.88 - 4.11	
	NAA		4.08		(1)			
	Others		4.04		(1)			
JG-2	Overall	Mean (All)	4.694	± 0.083	(23)		4.47 - 4.79	1.77
		Mean (± 2 S.D.)	4.715	± 0.048	(21)	4.72	4.63 - 4.79	1.02
		Mean (± 1 S.D.)	4.707	± 0.040	(19)		4.63 - 4.77	0.85
	FE	Mean (All)	4.735		(2)		4.73 - 4.74	
	AA	Mean (All)	4.701	± 0.099	(9)		4.47 - 4.79	2.10
		Mean (± 2 S.D.)	4.730	± 0.052	(8)	4.75	4.68 - 4.79	1.10
		Mean (± 1 S.D.)	4.730	± 0.052	(8)		4.64 - 4.79	1.10
	XRF	Mean (all)	4.696	± 0.048	(10)		4.63 - 4.79	1.02
		Mean (± 2 S.D.)	4.696	± 0.048	(10)	4.69	4.63 - 4.79	1.02
		Mean (± 1 S.D.)	4.693	± 0.032	(8)		4.65 - 4.74	0.68
	γ cntg.		4.74		(1)			
	NAA		4.48		(1)			
JG-3	Overall	Mean (All)	2.640	± 0.050	(21)		2.57 - 2.78	1.89
		Mean (± 2 S.D.)	2.633	± 0.039	(20)	2.62	2.57 - 2.71	1.48
		Mean (± 1 S.D.)	2.629	± 0.020	(14)		2.61 - 2.67	0.76
	FE	Mean (All)	2.643	± 0.025	(3)		2.62 - 2.67	0.95
		Mean (± 2 S.D.)	2.643	± 0.025	(3)	2.64	2.62 - 2.67	0.95
		Mean (± 1 S.D.)	2.630		(2)		2.62 - 2.64	
	AA	Mean (All)	2.635	± 0.019	(6)		2.61 - 2.66	0.72
		Mean (± 2 S.D.)	2.635	± 0.019	(6)	2.64	2.61 - 2.66	0.72
		Mean (± 1 S.D.)	2.635	± 0.013	(4)		2.62 - 2.65	0.49
	XRF	Mean (All)	2.611	± 0.034	(9)		2.57 - 2.69	1.62
		Mean (± 2 S.D.)	2.601	± 0.019	(8)	2.61	2.57 - 2.62	0.73
		Mean (± 1 S.D.)	2.606	± 0.015	(7)		2.58 - 2.62	0.58
	γ cntg.		2.71		(1)			
	NAA		2.78		(1)			
	Others		2.71		(1)			
JR-1	Overall	Mean (All)	4.412	± 0.168	(48)		4.06 - 5.04	3.88
		Mean (± 2 S.D.)	4.405	± 0.112	(44)	4.41	4.14 - 4.69	2.54
		Mean (± 1 S.D.)	4.410	± 0.070	(39)		4.25 - 4.54	1.59
	FE	Mean (All)	4.500	± 0.327	(5)		4.15 - 5.04	7.27
		Mean (± 2 S.D.)	4.500	± 0.327	(5)	4.45	4.15 - 5.04	7.27
		Mean (± 1 S.D.)	4.437	± 0.032	(3)		4.40 - 4.46	0.72
	AA	Mean (All)	4.388	± 0.115	(13)		4.06 - 4.52	2.62
		Mean (± 2 S.D.)	4.416	± 0.062	(12)	4.43	4.30 - 4.52	1.50
		Mean (± 1 S.D.)	4.406	± 0.055	(11)		4.30 - 4.47	1.24

1987 compilation of K<sub>2</sub>O concentrations in GSJ rock reference samples (Ando et al.)

XRF	Mean (All)	4.410	±	0.145	(22)		4.07 - 4.69	3.29	
	Mean (± 2 S.D.)	4.427	±	0.127	(21)	4.41	4.16 - 4.69	2.87	
	Mean (± 1 S.D.)	4.422	±	0.072	(17)		4.30 - 4.54	1.63	
ICP		4.42			(1)				
MWP		4.34			(1)				
γ cntg.	Mean (All)	4.29			(2)		4.14 - 4.44		
NAA		4.61			(2)		4.40 - 4.44		
Others	Mean (All)	4.325			(2)		4.28 - 4.37		
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JR-2	Overall	Mean (All)	4.449	±	0.125	(38)		4.09 - 4.73	2.83
		Mean (± 2 S.D.)	4.451	±	0.103	(36)	4.45	4.21 - 4.63	2.31
		Mean (± 1 S.D.)	4.465	±	0.062	(29)		4.35 - 4.56	1.39
FE	Mean (All)	4.426	±	0.127	(5)		4.21 - 4.52	2.86	
	Mean (± 2 S.D.)	4.426	±	0.127	(5)	4.47	4.21 - 4.52	2.86	
	Mean (± 1 S.D.)	4.480	±	0.045	(4)		4.42 - 4.52	1.00	
AA	Mean (All)	4.474	±	0.072	(8)		4.36 - 4.59	1.61	
	Mean (± 2 S.D.)	4.474	±	0.072	(8)	4.47	4.36 - 4.59	1.61	
	Mean (± 1 S.D.)	4.473	±	0.045	(6)		4.42 - 4.54	1.01	
XRF	Mean (All)	4.457	±	0.113	(19)		4.22 - 4.73	2.54	
	Mean (± 2 S.D.)	4.455	±	0.079	(17)	4.45	4.30 - 4.58	1.77	
	Mean (± 1 S.D.)	4.457	±	0.066	(15)		4.35 - 4.56	1.48	
ICP		4.22			(1)				
γ cntg.	Mean (All)	4.25			(2)		4.09 - 4.41		
NAA		4.59			(2)		4.54 - 4.63		
Others		4.56			(1)				
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JA-1	Overall	Mean (All)	0.774	±	0.056	(48)		0.58 - 0.91	7.23
		Mean (± 2 S.D.)	0.775	±	0.037	(44)	0.77	0.70 - 0.85	4.77
		Mean (± 1 S.D.)	0.770	±	0.028	(37)		0.72 - 0.82	3.64
FE	Mean (All)	0.780	±	0.028	(5)		0.76 - 0.83	3.59	
	Mean (± 2 S.D.)	0.780	±	0.028	(5)	0.77	0.76 - 0.83	3.59	
	Mean (± 1 S.D.)	0.768	±	0.005	(4)		0.76 - 0.77	0.65	
AA	Mean (All)	0.800	±	0.058	(11)		0.70 - 0.91	7.25	
	Mean (± 2 S.D.)	0.800	±	0.058	(11)	0.80	0.70 - 0.91	7.25	
	Mean (± 1 S.D.)	0.808	±	0.031	(8)		0.76 - 0.85	3.84	
XRF	Mean (All)	0.777	±	0.039	(23)		0.72 - 0.91	5.02	
	Mean (± 2 S.D.)	0.771	±	0.027	(22)	0.78	0.72 - 0.82	3.50	
	Mean (± 1 S.D.)	0.774	±	0.020	(19)		0.74 - 0.81	2.58	
ICP	Mean (All)	0.710	±	0.125	(3)	0.72	0.58 - 0.83	17.61	
	Mean (± 2 S.D.)	0.775			(2)		0.72 - 0.83		

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	MWP		0.83		(1)				
	γ cntg.		0.73		(2)		0.70 - 0.76		
	NAA		0.75		(1)				
	Others	Mean(All)	0.685		(2)		0.65 - 0.72		
JA-2	Overall	Mean(All)	1.797	±	0.056	(22)		1.69 - 1.90	2.78
		Mean(± 2 S.D.)	1.798	±	0.040	(20)	1.80	1.72 - 1.88	2.22
		Mean(± 1 S.D.)	1.793	±	0.027	(17)		1.75 - 1.84	1.51
		FE	Mean(All)	1.795		(2)		1.77 - 1.82	
	AA	Mean(All)	1.786	±	0.058	(8)		1.69 - 1.90	3.25
		Mean(± 2 S.D.)	1.786	±	0.058	(8)	1.79	1.69 - 1.90	3.25
		Mean(± 1 S.D.)	1.783	±	0.014	(6)		1.76 - 1.80	0.79
	XRF	Mean(All)	1.801	±	0.048	(10)		1.72 - 1.88	2.67
		Mean(± 2 S.D.)	1.801	±	0.048	(10)	1.81	1.72 - 1.88	2.67
		Mean(± 1 S.D.)	1.813	±	0.029	(6)		1.76 - 1.84	1.60
		γ cntg.		1.87		(1)			
		NAA		1.78		(1)			
JA-3	Overall	Mean(All)	1.419	±	0.032	(20)		1.36 - 1.50	2.26
		Mean(± 2 S.D.)	1.414	±	0.026	(19)	1.41	1.36 - 1.47	1.84
		Mean(± 1 S.D.)	1.414	±	0.019	(17)		1.39 - 1.45	1.34
	FE	Mean(All)	1.433	±	0.021	(3)		1.41 - 1.45	1.47
		Mean(± 2 S.D.)	1.433	±	0.021	(3)	1.44	1.41 - 1.45	1.47
		Mean(± 1 S.D.)	1.445		(2)			1.44 - 1.45	
	AA	Mean(All)	1.434	±	0.040	(5)		1.39 - 1.50	2.73
		Mean(± 2 S.D.)	1.434	±	0.040	(5)	1.43	1.39 - 1.50	2.73
		Mean(± 1 S.D.)	1.427	±	0.006	(3)		1.42 - 1.43	0.42
	XRF	Mean(All)	1.403	±	0.022	(9)		1.36 - 1.44	1.57
		Mean(± 2 S.D.)	1.403	±	0.022	(9)	1.41	1.36 - 1.44	1.57
		Mean(± 1 S.D.)	1.404	±	0.011	(7)		1.39 - 1.42	0.78
		γ cntg.		1.39		(1)			
		NAA		1.41		(1)			
		Others		1.47		(1)			
JB-1	Overall	Mean(All)	1.424	±	0.079	(64)		1.19 - 1.62	5.55
		Mean(± 2 S.D.)	1.432	±	0.051	(58)	1.43	1.31 - 1.57	3.56
		Mean(± 1 S.D.)	1.430	±	0.038	(51)		1.35 - 1.50	2.66
	FE	Mean(All)	1.383	±	0.070	(18)		1.20 - 1.46	5.06
		Mean(± 2 S.D.)	1.404	±	0.036	(16)	1.41	1.31 - 1.46	2.56
		Mean(± 1 S.D.)	1.407	±	0.024	(14)		1.34 - 1.45	1.71

1987 compilation of K<sub>2</sub>O concentrations in GSJ rock reference samples (Ando et al.)

AA	Mean (All)	1.443	±	0.034	(16)		1.40 - 1.50	2.35	
	Mean (± 2 S.D.)	1.443	±	0.034	(16)	1.45	1.40 - 1.50	2.35	
	Mean (± 1 S.D.)	1.450	±	0.017	(10)		1.42 - 1.47	1.17	
XRF	Mean (All)	1.456	±	0.068	(13)		1.35 - 1.60	4.67	
	Mean (± 2 S.D.)	1.444	±	0.055	(12)	1.44	1.35 - 1.55	3.81	
	Mean (± 1 S.D.)	1.450	±	0.034	(9)		1.41 - 1.51	2.34	
EPMA		1.47			(1)				
OS (DR)		1.38			(1)				
ICP	Mean (All)	1.388	±	0.107	(4)		1.25 - 1.49	7.71	
	Mean (± 2 S.D.)	1.388	±	0.107	(4)	1.41	1.25 - 1.49	7.71	
	Mean (± 1 S.D.)	1.433	±	0.067	(3)		1.36 - 1.49	4.68	
γ cntg.	Mean (All)	1.466	±	0.051	(5)		1.38 - 1.51	3.48	
	Mean (± 2 S.D.)	1.466	±	0.051	(5)	1.49	1.38 - 1.51	3.48	
	Mean (± 1 S.D.)	1.488	±	0.021	(4)		1.46 - 1.51	1.41	
NAA	Mean (All)	1.30			(2)		1.19 - 1.41		
Vol.		1.57			(1)				
Grav.	Mean (All)	1.355			(2)		1.34 - 1.37		
Others		1.62			(1)				
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JB-1a	Overall	Mean (All)	1.415	±	0.058	(27)		1.23 - 1.58	4.10
		Mean (± 2 S.D.)	1.416	±	0.033	(25)	1.40	1.36 - 1.51	2.33
		Mean (± 1 S.D.)	1.412	±	0.027	(24)		1.36 - 1.46	1.91
FE	Mean (All)	1.433	±	0.031	(3)		1.40 - 1.46	2.16	
	Mean (± 2 S.D.)	1.433	±	0.031	(3)	1.44	1.40 - 1.46	2.16	
	Mean (± 1 S.D.)	1.433	±	0.031	(3)		1.40 - 1.46	2.16	
AA	Mean (All)	1.418	±	0.036	(8)		1.36 - 1.46	2.54	
	Mean (± 2 S.D.)	1.418	±	0.036	(8)	1.42	1.36 - 1.46	2.54	
	Mean (± 1 S.D.)	1.428	±	0.023	(5)		1.40 - 1.45	1.61	
XRF	Mean (All)	1.413	±	0.033	(13)		1.38 - 1.51	2.34	
	Mean (± 2 S.D.)	1.405	±	0.016	(12)	1.40	1.38 - 1.44	1.14	
	Mean (± 1 S.D.)	1.407	±	0.015	(11)		1.39 - 1.44	1.07	
γ cntg.		1.39			(1)				
NAA		1.58			(1)				
Others		1.23			(1)				
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JB-2	Overall	Mean (All)	0.414	±	0.028	(47)		0.35 - 0.48	6.76
		Mean (± 2 S.D.)	0.411	±	0.022	(43)	0.42	0.36 - 0.45	5.35
		Mean (± 1 S.D.)	0.418	±	0.013	(35)		0.39 - 0.44	3.11
FE	Mean (All)	0.435	±	0.027	(5)		0.415- 0.48	6.21	
	Mean (± 2 S.D.)	0.435	±	0.027	(5)	0.42	0.415- 0.48	6.21	
	Mean (± 1 S.D.)	0.424	±	0.011	(4)		0.415- 0.44	2.59	

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AA	Mean (All)	0.411	±	0.028	(12)		0.35 - 0.45	6.81	
	Mean (± 2 S.D.)	0.416	±	0.022	(11)	0.42	0.37 - 0.45	5.29	
	Mean (± 1 S.D.)	0.418	±	0.014	(9)		0.39 - 0.43	3.35	
XRF	Mean (All)	0.417	±	0.027	(22)		0.36 - 0.47	6.47	
	Mean (± 2 S.D.)	0.420	±	0.024	(21)	0.42	0.37 - 0.47	5.71	
	Mean (± 1 S.D.)	0.419	±	0.013	(17)		0.40 - 0.44	3.10	
ICP		0.38			(2)		0.37 - 0.39		
MWP		0.38			(1)				
Y cntg. Mean		0.415			(2)		0.40 - 0.43		
NAA		0.38			(1)				
Others	Mean (All)	0.415			(2)		0.41 - 0.42		
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JB-3	Overall	Mean (All)	0.774	±	0.037	(35)		0.64 - 0.83	4.78
		Mean (± 2 S.D.)	0.778	±	0.028	(33)	0.78	0.72 - 0.83	3.60
		Mean (± 1 S.D.)	0.779	±	0.020	(27)		0.72 - 0.81	2.57
FE	Mean (All)	0.778	±	0.022	(6)		0.75 - 0.81	2.82	
	Mean (± 2 S.D.)	0.778	±	0.022	(6)	0.77	0.75 - 0.81	2.82	
	Mean (± 1 S.D.)	0.778	±	0.015	(4)		0.77 - 0.80	1.92	
AA	Mean (All)	0.789	±	0.020	(8)		0.76 - 0.82	2.53	
	Mean (± 2 S.D.)	0.789	±	0.020	(8)	0.79	0.76 - 0.82	2.53	
	Mean (± 1 S.D.)	0.788	±	0.015	(6)		0.77 - 0.80	1.90	
XRF	Mean (All)	0.762	±	0.043	(16)		0.64 - 0.82	5.64	
	Mean (± 2 S.D.)	0.770	±	0.029	(15)	0.77	0.72 - 0.82	3.77	
	Mean (± 1 S.D.)	0.763	±	0.024	(13)		0.72 - 0.79	3.15	
ICP		0.83			(1)				
Y cntg. Mean (all)		0.77	±	0.04	(3)		0.72 - 0.80	5.71	
Others		0.80			(1)				
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JGb-1	Overall	Mean (all)	0.238	±	0.026	(32)		0.19 - 0.33	10.92
		Mean (± 2 S.D.)	0.235	±	0.020	(31)	0.24	0.19 - 0.28	8.51
		Mean (± 1 S.D.)	0.240	±	0.012	(25)		0.22 - 0.26	5.00
FE	Mean (all)	0.230	±	0.022	(4)		0.20 - 0.25	9.57	
	Mean (± 2 S.D.)	0.230	±	0.022	(4)	0.24	0.20 - 0.25	9.57	
	Mean (± 1 S.D.)	0.240	±	0.010	(3)		0.23 - 0.25	4.17	
AA	Mean (All)	0.244	±	0.035	(9)		0.21 - 0.33	15.63	
	Mean (± 2 S.D.)	0.233	±	0.016	(8)	0.23	0.21 - 0.26	6.87	
	Mean (± 1 S.D.)	0.233	±	0.016	(8)		0.21 - 0.26	6.87	
XRF	Mean (All)	0.236	±	0.023	(16)		0.19 - 0.28	9.75	
	Mean (± 2 S.D.)	0.236	±	0.023	(16)	0.24	0.19 - 0.28	9.75	
	Mean (± 1 S.D.)	0.237	±	0.011	(10)		0.22 - 0.25	4.64	

1987 compilation of  $K_2O$  concentrations in GSJ rock reference samples (Ando et al.)

	Y cntg.	Mean (All)	0.240		(2)		0.24 - 0.24		
	Others		0.25		(1)				
JP-1	Overall	Mean (All)	0.0113 ±	0.0089	(17)		0.003- 0.03	78.76	
		Mean (± 2 S.D.)	0.00885±	0.0058	(15)	0.0090	0.003- 0.02	65.54	
		Mean (± 1 S.D.)	0.00885±	0.0058	(15)		0.003- 0.02	65.54	
	AA	Mean (All)	0.00587±	0.0048	(6)		0.003- 0.015	81.77	
		Mean (± 2 S.D.)	0.00587±	0.0048	(6)	0.0034	0.003- 0.015	81.77	
		Mean (± 1 S.D.)	0.00404±	0.0020	(5)		0.003- 0.0075	49.50	
	XRF	Mean (All)	0.0174 ±	0.0090	(8)		0.009- 0.03	51.72	
		Mean (± 2 S.D.)	0.0174 ±	0.0090	(8)	0.015	0.009- 0.03	51.72	
		Mean (± 1 S.D.)	0.0132 ±	0.0053	(6)		0.009- 0.02	40.15	
		Y cntg.		0.0044		(1)			
		NAA		0.0041		(1)			
		Others		0.01		(1)			
	JF-1	Overall	Mean (All)	9.939 ±	0.139	(21)		9.68 -10.12	1.40
			Mean (± 2 S.D.)	9.939 ±	0.139	(21)	9.96	9.68 -10.12	1.40
			Mean (± 1 S.D.)	9.958 ±	0.102	(14)		9.80 -10.07	1.02
FE		Mean (All)	9.940		(2)		9.89 - 9.99		
AA		Mean (All)	10.048 ±	0.079	(8)		9.86 -10.11	0.79	
		Mean (± 2 S.D.)	10.074 ±	0.022	(7)	10.07	10.05 -10.11	0.22	
		Mean (± 1 S.D.)	10.074 ±	0.022	(7)		10.05 -10.11	0.22	
XRF		Mean (All)	9.85 ±	0.136	(10)		9.68 -10.12	1.38	
		Mean (± 2 S.D.)	9.85 ±	0.136	(10)	9.81	9.68 -10.12	1.38	
		Mean (± 1 S.D.)	9.81 ±	0.059	(7)		9.72 - 9.91	0.60	
		Y cntg.		9.96		(1)			
JF-2		Overall	Mean (All)	12.952 ±	0.321	(19)		12.05 -13.40	2.48
			Mean (± 2 S.D.)	13.003 ±	0.242	(18)	13.04	12.49 -13.40	1.86
			Mean (± 1 S.D.)	13.069 ±	0.120	(14)		12.89 -13.25	0.92
		FE	Mean (All)	13.087 ±	0.106	(3)	13.07	12.99 -13.20	0.81
	Mean (± 2 S.D.)		13.030		(2)		12.99 -13.07		
	AA	Mean (All)	13.112 ±	0.087	(5)		13.03 -13.25	0.66	
		Mean (± 2 S.D.)	13.112 ±	0.087	(5)	13.10	13.03 -13.25	0.66	
		Mean (± 1 S.D.)	13.078 ±	0.046	(4)		13.03 -13.13	0.35	
	XRF	Mean (All)	12.798 ±	0.412	(9)		12.05 -13.40	3.22	
		Mean (± 2 S.D.)	12.798 ±	0.412	(9)	12.89	12.05 -13.40	3.22	
		Mean (± 1 S.D.)	12.747 ±	0.209	(6)		12.49 -13.00	1.63	
		Y cntg.		12.94		(1)			
		Others		13.16		(1)			

Table A-2 Analytical results for potassium in GSJ rock reference samples, "Igneous rock series".

K <sub>2</sub> O(%)	Method	Reference	Year	K <sub>2</sub> O(%)	Method	Reference	Year
JG-1							
4.09	FE	Res. Lab. Asahi Glass Co. Ltd.	1967	3.95	XRF	CORNELL	1976
				3.98	XRF	KYLE	1976
4.17	FE	Mitaka Lab. Nittetsu Mining Co. Ltd.	1967	3.91	XRF	BEST <i>et al.</i>	1976
				3.99	XRF	TAKAMATSU	1978
3.92	FE	Cent. Res. Lab. Onoda Cement Co. Ltd.	1967	3.98	XRF	OGASAWARA	1979
				4.05	XRF	UJIKE	1982
4.10	FE	HARAMURA	1968	3.98	XRF	PARKER	1982
4.05	FE	Nihon Cement Res. Lab.	1968	3.99	XRF	SOLYOM	1985
4.11	FE	ZASHU	1968	4.00	XRF	GILL	1985
4.05	FE	AOKI	1969	3.96	XRF	NAKADA <i>et al.</i>	1985
3.96	FE	ONUKE	1969	3.92	EPMA	MORI	1972
3.94	FE	AOKI and ONUKE	1969	3.93	EPMA	MORI and GREEN	1976
3.88	FE	ABE	1970	3.95	OS (DR)	GOVINDARAJU	1968
3.99	FE	ISHIBASHI	1970	3.90	ICP	UCHIDA <i>et al.</i>	1984
3.76	FE	MURAKAMI	1970	3.99	ICP	DEBNAM	1984
3.67	FE	NAKAO	1970	4.02	ICP	GULKO	1985
3.99	FE	OHBA	1970	4.08	ICP	IMAI	1986
3.94	FE	SUGISAKI and TANAKA	1971	3.95	$\gamma$ cntg.	KANAYA	1970
3.96	FE	BEASLEY	1972	4.03	$\gamma$ cntg.	KANAYA	1971
3.93	FE	SHIRAHATA	1972	4.05	$\gamma$ cntg.	ADAMS	1972
3.93	FE	MARUYAMA and SUDA	1974	4.01	$\gamma$ cntg.	SATO <i>et al.</i>	1980
4.00	FE	REGLI	1975	3.92	$\gamma$ cntg.	BEIYAEV and SOBORNOV	1981
3.96	FE	INAZUMI	1982	3.96	$\gamma$ cntg.	KOMURA	1987
3.94	FE	YOSHIDA and AOKI	1985	4.05	IDMS	ISHIZAKA	1971
4.01	FE	NISHIDO <i>et al.</i>	1985	3.94	Grav.	MUNSON	1967
3.99	FE	MATSUMOTO, A.	1987	3.96	Grav.	HIKICHI	1968
3.96	AA	BOUVIER	1968	3.86	Grav.	MAEDA	1970
3.94	AA	KATO	1969	3.88	Grav.	OHMORI	1970
3.90	AA	KATO	1969	3.91	Grav.	OHTA	1972
3.91	AA	KURASAWA	1970	4.17	Unreported	VERNET	1968
3.96	AA	SHIBATA	1970	4.06	Unreported	FRIESE	1972
3.92	AA	TERASHIMA	1970	JG-1a			
3.97	AA	TIBA	1970	3.98	FE	OHBA	1986
3.98	AA	RANDALL	1972	4.03	FE	MATSUMOTO, A.	1987
4.00	AA	GAGNON	1974	4.02	AA	YAMASHIGE	1984
3.95	AA	SHIBATA and UCHIUMI	1974	4.01	AA	YAMASHIGE <i>et al.</i>	1984
4.02	AA	KANIZAWA	1974	3.98	AA	ZANETTIN	1986
3.95	AA	AYRANCI	1977	4.04	AA	TERASHIMA and ANDO	1987
3.96	AA	YAMAZAKI	1978	3.96	AA	HIRATE and YOKOTE	1987
4.00	AA	MUECKE	1979	3.79	AA	KASPER	1987
4.18	AA	HONMA	1981	4.05	AA	AYRANCI	1987
3.87	AA	INOUE <i>et al.</i>	1985	4.03	AA	BUGAGAO <i>et al.</i>	1987
4.02	AA	YAMASHIGE <i>et al.</i>	1985	4.00	XRF	SOTIRIOU	1984
3.97	AA	NARA <i>et al.</i>	1987	4.08	XRF	STANLEY	1984
3.90	XRF	SULLIVAN	1970	4.16	XRF	TANEMURA	1984
4.05	XRF	MURAD	1971				
3.86	XRF	STEELE	1971				



1987 compilation of K<sub>2</sub>O concentrations in GSF rock reference samples (Ando et al.)

K <sub>2</sub> O(%)	Method	Reference	Year	K <sub>2</sub> O(%)	Method	Reference	Year
4.23	XRF	CROUDACE	1984	2.62	AA	NARA <i>et al.</i>	1987
3.88	XRF	HUANG	1985	2.57	XRF	TANEMURA	1986
4.01	XRF	THOMPSON	1985	2.62	XRF	OLSZOWY <i>et al.</i>	1986
3.95	XRF	SOLYOM	1985	2.61	XRF	SOTIRIOU	1986
4.10	XRF	NAIDOO	1985	2.58	XRF	MERTZMAN	1986
4.00	XRF	ETOUBLEAU	1985	2.61	XRF	ETOUBREAU	1987
4.00	XRF	OLSZOWY	1985	2.69	XRF	ROELANDTS and BOLOGNE	1987
3.95	XRF	MERTZMAN	1985	2.59	XRF	YOSHIOKA	1987
4.00	XRF	ZANETTIN	1986	2.61	XRF	SOLYOM	1987
3.91	XRF	YOSHIOKA	1987	2.62	XRF	NIELSEN	1987
3.88	$\gamma$ cntg.	KOMURA and TAN	1985	2.71	$\gamma$ cntg.	KOMURA	1987
4.11	$\gamma$ cntg.	KOMURA	1987	2.78	NAA	WAKABAYASHI	1987
4.08	NAA	TONG CHUNHAN	1985	2.71	Unreported	RIANDEY	1987
4.04	Unreported	BALARAM	1985				
JG-2				JR-1			
4.74	FE	OHBA	1986	5.04	FE	PINTA	1983
4.73	FE	MATSUMOTO, A.	1987	4.15	FE	OHBA	1983
4.67	AA	YAMASHIGE	1985	4.45	FE	YOSIDA and AOKI	1985
4.76	AA	FUJINUKI	1985	4.40	FE	NISIDO <i>et al.</i>	1985
4.75	AA	ZANETTIN	1986	4.46	FE	MATSUMOTO, A.	1987
4.79	AA	TERASHIMA and ANDO	1987	4.30	AA	SAKATA	1982
4.64	AA	HIRATE and YOKOTE	1987	4.45	AA	SJÖBERG	1983
4.47	AA	KASPER	1987	4.06	AA	CHAREONKUL	1983
4.75	AA	AYRANCI	1987	4.44	AA	OHMORI	1983
4.77	AA	BUGAGAO <i>et al.</i>	1987	4.46	AA	SULASMORO	1983
4.71	AA	NARA <i>et al.</i>	1987	4.42	AA	JECKO	1983
4.72	XRF	SOTIRIOU	1985	4.33	AA	GAL	1983
4.70	XRF	ETOUBLEAU	1985	4.52	AA	TERASHIMA <i>et al.</i>	1984
4.68	XRF	NIEKERK	1985	4.36	AA	TIBA	1984
4.63	XRF	MERTZMAN	1985	4.47	AA	ZANETTIN	1986
4.66	XRF	KALF	1985	4.40	AA	AYRANCI	1987
4.79	XRF	TANEMURA	1985	4.44	AA	BUGAGAO	1987
4.74	XRF	ZANETTIN	1986	4.40	AA	NARA <i>et al.</i>	1987
4.72	XRF	OLSZOWY	1986	4.48	XRF	TANEMURA	1982
4.67	XRF	SOLYOM	1986	4.42	XRF	OGASAWARA and STANLEY	1982
4.65	XRF	YOSHIOKA	1987	4.25	XRF	YOSHIOKA	1983
4.74	$\gamma$ cntg.	KOMURA	1987	4.07	XRF	BOLOGNE	1983
4.48	NAA	WAKABAYASHI	1987	4.68	XRF	SØRENSEN and KRYSTROL	1983
				4.16	XRF	SAKAMOTO	1983
				4.36	XRF	SATO	1984
				4.69	XRF	CROUDACE	1984
				4.30	XRF	MATSUMOTO, R.	1984
				4.51	XRF	STANLEY	1984
				4.43	XRF	SOTIRIOU	1984
				4.34	XRF	TAKENAKA	1985
				4.41	XRF	SOLYOM	1985
				4.51	XRF	NAIDOO	1985
				4.47	XRF	ETOUBLEAU	1985
				4.40	XRF	OLSZOWY	1985
JG-3							
2.67	FE	OHBA	1986				
2.64	FE	SUZUKI	1986				
2.62	FE	MATSUMOTO, A.	1987				
2.64	AA	HIRATE and YOKOTE	1987				
2.66	AA	SOLYOM	1987				
2.65	AA	AYRANCI	1987				
2.63	AA	TERASHIMA and ANDO	1987				
2.61	AA	BUGAGAO <i>et al.</i>	1987				

K <sub>2</sub> O(%)	Method	Reference	Year	K <sub>2</sub> O(%)	Method	Reference	Year
4.38	XRF	MERTZMAN	1985	4.22	ICP	IMAI	1986
4.37	XRF	HUANG	1985	4.09	$\gamma$ cntg.	KOMURA and TAN	1985
4.52	XRF	THOMPSON	1985	4.41	$\gamma$ cntg.	KOMURA	1987
4.33	XRF	NAKADA	1985	4.63	NAA	TONG CHUNHAN	1985
4.54	XRF	BOWER	1985	4.54	NAA	WAKABAYASHI	1987
4.41	XRF	ZANETTIN	1986	4.56	Unreported	MOLDAN	1984
4.42	ICP	IMAI	1986	<hr/>			
4.34	MWP	GOVINDARAJU	1983	JA-1			
4.14	$\gamma$ cntg.	KOMURA and TAN	1985	.83	FE	PINTA	1983
4.44	$\gamma$ cntg.	KOMURA	1987	.77	FE	OHBA	1983
4.81	NAA	TONG CHUNHAN	1985	.76	FE	YOSHIDA and AOKI	1985
4.40	NAA	BOWER	1985	.77	FE	NISHIDO <i>et al.</i>	1985
4.28	Unreported	MOLDAN	1984	.77	FE	MATSUMOTO, A.	1987
4.37	Unreported	BALARAM	1985	.82	AA	SULASMORO	1983
<hr/>				.73	AA	GAL	1983
JR-2				.78	AA	SJÖBERG	1983
4.21	FE	OHBA	1983	.70	AA	CHAREONKUL	1983
4.42	FE	PINTA	1983	.82	AA	OHMORI	1983
4.52	FE	YOSHIDA and AOKI	1985	.80	AA	TERASHIMA <i>et al.</i>	1984
4.47	FE	NISHIDO <i>et al.</i>	1985	.91	AA	TIBA	1984
4.51	FE	MATSUMOTO, A.	1987	.76	AA	ZANETTIN	1986
4.48	AA	OHMORI	1983	.85	AA	AYRANCI	1987
4.54	AA	TERASHIMA <i>et al.</i>	1984	.84	AA	BUGAGAO <i>et al.</i>	1987
4.51	AA	SJÖBERG	1984	.79	AA	NARA <i>et al.</i>	1987
4.44	AA	TIBA	1984	.77	XRF	OGASAWARA and STANLEY	1982
4.42	AA	ZANETTIN	1986	.81	XRF	TANEMURA	1982
4.45	AA	AYRANCI	1987	.82	XRF	YOSHIOKA	1983
4.59	AA	BUGAGAO	1987	.76	XRF	BOLOGNE	1983
4.36	AA	NARA <i>et al.</i>	1987	.77	XRF	SØRENSEN and KYSTROL	1983
4.58	XRF	TANEMURA	1983	.72	XRF	SAKAMOTO	1983
4.30	XRF	YOSHIOKA	1983	.78	XRF	JECKO	1983
4.22	XRF	SAKAMOTO	1983	.78	XRF	STANLEY	1984
4.41	XRF	ROELANDTS	1983	.79	XRF	SATO	1984
4.42	XRF	JECKO	1983	.75	XRF	STOTIRIOU	1984
4.45	XRF	SATO	1984	.76	XRF	CROUDACE	1984
4.48	XRF	SOTIRIOU	1984	.78	XRF	MATSUMOTO, R.	1984
4.73	XRF	CROUDACE	1984	.79	XRF	SOLYOM	1985
4.35	XRF	MATSUMOTO, R.	1984	.79	XRF	NAIDOO	1985
4.55	XRF	STANLEY	1984	.72	XRF	BOWER <i>et al.</i>	1985
4.45	XRF	SOLYOM	1985	.81	XRF	ETOUBLEAU	1895
4.54	XRF	NAIDOO	1985	.79	XRF	OLSZOWY	1985
4.45	XRF	ETOUBLEAU	1985	.76	XRF	MERTZMAN	1985
4.54	XRF	OLSZOWY	1985	.76	XRF	HUANG	1985
4.44	XRF	MERTZMAN	1985	.74	XRF	THOMPSON	1985
4.38	XRF	HUANG	1985	.78	XRF	NAKADA <i>et al.</i>	1985
4.56	XRF	THOMPSON	1985	.91	XRF	TAKENAKA	1985
4.38	XRF	NAKADA	1985	.74	XRF	ZANETTIN	1986
4.46	XRF	ZANETTIN	1986	.83	ICP	UCHIDA <i>et al.</i>	1984
<hr/>				.72	ICP	BOWER <i>et al.</i>	1985

1987 compilation of K<sub>2</sub>O concentrations in GSJ rock reference samples (Ando et al.)

K <sub>2</sub> O(%)	Method	Reference	Year	K <sub>2</sub> O(%)	Method	Reference	Year
.58	ICP	IMAI	1986	1.41	XRF	NIELSEN	1987
.83	MWP	GOVINDARAJU	1983	1.39	$\gamma$ cntg.	KOMURA	1987
.70	$\gamma$ cntg.	KOMURA and TAN	1985	1.41	NAA	WAKABAYASHI	1987
.76	$\gamma$ cntg.	KOMURA	1987	1.47	Unreported	RIANDEY	1987
.75	NAA	BOWER <i>et al.</i>	1985	JB-1			
.72	Unreported	MOLDAN	1984	1.45	FE	ZASHU	1968
.65	Unreported	BALARAM	1985	1.41	FE	AOKI	1969
JA-2				1.39	FE	AOKI and ONUKI	1969
1.82	FE	OHBA	1986	1.41	FE	ONUKE	1969
1.77	FE	MATSUMOTO, A.	1987	1.46	FE	ABE	1970
1.78	AA	YAMASHIGE	1985	1.41	FE	ISHIBASHI	1970
1.78	AA	FUJINUKI	1985	1.23	FE	NAKAO	1970
1.76	AA	ZANETTIN	1986	1.34	FE	OHBA	1970
1.80	AA	TERASHIMA and ANDO	1987	1.20	FE	UCHIDA	1970
1.69	AA	KASPER	1987	1.31	FE	SUGISAKI and TANAKA	1971
1.90	AA	AYRANCI	1987	1.40	FE	BEASLEY	1972
1.79	AA	BUGAGAO <i>et al.</i>	1987	1.40	FE	SHIRAHATA	1972
1.79	AA	NARA <i>et al.</i>	1987	1.41	FE	MARUYAMA and SUDA	1974
1.78	XRF	STOTIRIOU	1985	1.40	FE	REGLI	1975
1.84	XRF	TANEMURA	1985	1.42	FE	INAZUMI	1982
1.88	XRF	ETOUBLEAU	1985	1.41	FE	YOSHIDA and AOKI	1985
1.72	XRF	NIEKERK	1985	1.43	FE	NISHIDO <i>et al.</i>	1985
1.83	XRF	MERTZMAN	1985	1.42	FE	MATSUMOTO, A.	1987
1.82	XRF	KALF	1985	1.44	AA	KATO	1969
1.76	XRF	ZANETTIN	1986	1.43	AA	KATO	1969
1.83	XRF	OLSZOWY	1986	1.47	AA	BOUVIER	1970
1.75	XRF	SOLYOM	1986	1.40	AA	GRUSHMAN	1970
1.80	XRF	YOSHIOKA	1987	1.40	AA	KURASAWA	1970
1.87	$\gamma$ cntg.	KOMURA	1987	1.40	AA	TERASHIMA	1970
1.78	NAA	WAKABAYASHI	1987	1.46	AA	TIBA	1970
JA-3				1.50	AA	RANDALL	1972
1.45	FE	SUZUKI	1986	1.50	AA	GAGNON	1974
1.44	FE	OKBA	1986	1.47	AA	KANIZAWA	1974
1.41	FE	MATSUMOTO, A.	1987	1.46	AA	TAKAI and KANEHIRA	1975
1.43	AA	TERASHIMA and ANDO	1987	1.40	AA	AYRANCI	1977
1.42	AA	SOLYOM	1987	1.45	AA	MUECKE	1979
1.50	AA	AYRANCI	1987	1.44	AA	YAMASHIGE <i>et al.</i>	1985
1.43	AA	BUGAGAO <i>et al.</i>	1987	1.46	AA	INOUE <i>et al.</i>	1985
1.39	AA	NARA <i>et al.</i>	1987	1.42	AA	NARA <i>et al.</i>	1987
1.36	XRF	TANEMURA	1986	1.55	XRF	SULLIVAN	1970
1.39	XRF	OLSZOWY <i>et al.</i>	1986	1.60	XRF	WEIGAND	1970
1.41	XRF	SOTIRIOU	1986	1.49	XRF	MURAD	1971
1.39	XRF	MERTZMAN	1986	1.35	XRF	CORNELL	1976
1.42	XRF	ETOUBLEAU	1987	1.38	XRF	BEST <i>et al.</i>	1976
1.44	XRF	ROELANDTS and BOLOGNE	1987	1.41	XRF	TAKAMATSU	1978
1.40	XRF	YOSHIOKA	1987	1.43	XRF	OGASAWARA	1979
1.41	XRF	SOLYOM	1987	1.44	XRF	KOBAYASHI <i>et al.</i>	1981
				1.47	XRF	UJIKE	1982



1987 compilation of K<sub>2</sub>O concentrations in GSJ rock reference samples (Ando et al.)

K <sub>2</sub> O(%)	Method	Reference	Year	K <sub>2</sub> O(%)	Method	Reference	Year
.38	NAA	BOWER <i>et al.</i>	1985	.23	AA	SJÖBERG	1984
.42	Unreported	NOHDA	1982	.33	AA	TIBA	1984
.41	Unreported	MOLDAN	1984	.21	AA	ZANETTIN	1986
JB-3				.25	AA	AYRANCI	1987
.77	FE	OHBA	1983	.23	AA	BUGAGAO <i>et al.</i>	1987
.75	FE	PINTA	1983	.23	AA	NARA <i>et al.</i>	1987
.80	FE	OHBA and TAKAHASHI	1983	.24	XRF	TANEMURA	1983
.77	FE	NISHIDO <i>et al.</i>	1985	.28	XRF	YOSHIOKA	1983
.81	FE	SUZUKI	1986	.23	XRF	JECKO	1983
.77	FE	MATSUMOTO, A.	1987	.24	XRF	MATSUMOTO, R.	1984
.80	AA	OHMORI	1983	.24	XRF	STANLEY	1984
.80	AA	TERASHIMA <i>et al.</i>	1984	.25	XRF	CROUDACE	1984
.76	AA	SJÖBERG	1984	.21	XRF	SOTIRIOU	1984
.82	AA	TIBA	1984	.25	XRF	HUANG	1985
.77	AA	ZANETTIN	1986	.20	XRF	THOMPSON	1985
.80	AA	AYRANCI	1987	.24	XRF	NAKADA	1985
.79	AA	BUGAGAO <i>et al.</i>	1987	.26	XRF	SOLYOM	1985
.77	AA	NARA <i>et al.</i>	1987	.24	XRF	NAIDOO	1985
.79	XRF	TANEMURA	1983	.26	XRF	ETOUBLEAU	1985
.82	XRF	YOSHIOKA	1983	.22	XRF	OLSZOWY	1985
.72	XRF	ROELANDTS	1983	.22	XRF	MERTZMAN	1985
.64	XRF	SATO	1984	.19	XRF	ZANETTIN	1986
.75	XRF	SOTIRIOU	1984	.24	$\gamma$ cntg.	KOMURA and TAN	1985
.75	XRF	CROUDACE	1984	.24	$\gamma$ cntg.	KOMURA	1987
.79	XRF	MATSUMOTO, R.	1984	.25	Unreported	MOLDAN	1984
.77	XRF	STANLEY	1984	JP-1			
.76	XRF	HUANG	1985	.0031	AA	YAMASHIGE	1984
.81	XRF	THOMPSON	1985	.0036	AA	YAMASHIGE	1985
.78	XRF	SOLYOM	1985	.015	AA	ZANETTIN	1986
.78	XRF	NAIDOO	1985	.003	AA	TERASHIMA and ANDO	1987
.79	XRF	ETOUBLEAU	1985	.0075	AA	AYRANCI	1987
.74	XRF	OLSZOWY	1985	.003	AA	BUGAGAO <i>et al.</i>	1987
.77	XRF	MERTZMAN	1985	.01	XRF	CROUDACE	1984
.73	XRF	ZANETTIN	1986	.00	XRF	STANLEY	1984
.83	ICP	IMAI	1986	<.01	XRF	STOTIRIOU	1984
.72	$\gamma$ cntg.	SATO	1984	.03	XRF	SOLYOM	1985
.79	$\gamma$ cntg.	KOMURA and TAN	1985	.01	XRF	NAIDOO	1985
.80	$\gamma$ cntg.	KOMURA	1987	.02	XRF	ETOUBLEAU	1985
.80	Unreported	MOLDAN	1984	.02	XRF	OLSZOWY	1985
JGb-1				.00	XRF	MERTZMAN	1985
.20	FE	PINTA	1983	.009	XRF	HUANG	1985
.25	FE	YOSHIDA and AOKI	1985	.01	XRF	THOMPSON	1985
.24	FE	NISHIDO <i>et al.</i>	1985	<.01	XRF	NAKADA	1985
.23	FE	MATSUMOTO, A.	1987	.03	XRF	KALF	1985
.22	AA	NAKAJIMA	1983	.0044	$\gamma$ cntg.	KOMUMA and TAN	1985
.26	AA	OHMORI	1983	.0041	NAA	EBIHARA	1985
.24	AA	TERASHIMA <i>et al.</i>	1984	<.1	Unreported	RIANDEY	1984

K <sub>2</sub> O(%)	Method	Reference	Year	K <sub>2</sub> O(%)	Method	Reference	Year
.01	Unreported	BALARAM	1985	9.96	$\gamma$ cntg.	KOMURA	1987
JF-1				JF-2			
9.89	FE	OHBA	1986	12.99	FE	OHBA	1986
9.99	FE	MATSUMOTO, A.	1987	13.20	FE	SUZUKI	1986
10.07	AA	YAMASHIGE	1985	13.07	FE	MATSUMOTO, A.	1987
10.05	AA	FUJINUKI	1985	13.03	AA	SOLYOM	1987
10.11	AA	ZANETTIN	1986	13.25	AA	AYRANCI	1987
10.06	AA	TERASHIMA and ANDO	1987	13.10	AA	TERASHIMA and ANDO	1987
9.86	AA	KASPER	1987	13.13	AA	BUGAGAO <i>et al.</i>	1987
10.10	AA	AYRANCI	1987	13.05	AA	NARA <i>et al.</i>	1987
10.07	AA	BUGAGAO <i>et al.</i>	1987	13.25	XRF	TANEMURA	1986
10.06	AA	NARA <i>et al.</i>	1987	13.00	XRF	OLSZOWY <i>et al.</i>	1986
9.79	XRF	SOTIRIOU	1985	12.90	XRF	SOTIRIOU	1986
9.85	XRF	ETOUBLEAU	1985	12.49	XRF	MERTZMAN	1986
9.80	XRF	NIEKERK	1985	12.63	XRF	ETOUBEAU	1987
9.68	XRF	MERTZMAN	1985	12.05	XRF	ROELANDTS and BOLOGNE	1987
9.79	XRF	KALF	1985	12.57	XRF	YOSHIOKA	1987
10.12	XRF	TANEMURA	1985	13.40	XRF	SOLYOM	1987
10.03	XRF	ZANETTIN	1986	12.89	XRF	NIELSEN	1987
9.91	XRF	OLSZOWY	1986	12.94	$\gamma$ cntg.	KOMURA	1987
9.81	XRF	SOLYOM	1986	13.16	Unreported	RIANDEY	1987
9.72	XRF	YOSHIOKA	1987				

Code for analytical methods.

Code	Method
AA	Atomic absorption spectrometry
EPMA	Electron probe micro-analysis
FE	Flame emission spectrometry
Grav.	Gravimetry
ICP	Induction coupled plasma optical emission spectrometry
IDMS	Isotope dilution mass spectrometry
MWP	Microwave plasma optical emission spectrometry
NAA	Neutron activation analysis, unspecified
OS (DR)	Optical emission spectrometry (direct reading)
Vol.	Volumetry
XRF	X-ray fluorescence, unspecified
$\gamma$ cntg.	$\gamma$ -ray counting

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