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Petrochemistry of Andesites from Jaishi Volcano, Izu Peninsula

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Abstract Trace element abundances of andesite lavas from Jaishi volcano have been determined by X-ray fluorescence. Primitive mantle-normalized incompatible element pattern of these andesites is typical of calc-alkaline andesites, with distinct K, Ba and Rb enrichment and notable Ti depletion. In a Sr/Ca-Ba/Ca diagram, these andesites do not give any Sr/Ca-Ba/Ca systematics, suggesting no effective fractional crystallization had taken place within the magma chamber during lava flow issuing activity.

Introduction

In and around the Izu Peninsula, many Quarternary volcanoes are known. The rocks of these volcanoes range from tholeiite, high-alumina basalt to alkali rock series and their derivatives. And these volcanoes are arranged within a zone narrower than 60 km to the west of the volcanic front (Fig. 1). Among these volcanoes, Jaishi volcano that is situated at the southwestern part of the Izu Peninsula does not give a distinct clue to estimate the nature of the parental magma, because its products are andesite only of calc-alkaline rock series (TIBA *et al.*, 1982). Recently trace element abundances, especially incompatible element patterns, proved to be useful as an indicator of the tectonic environment of magma genesis. The authors present trace element abundances in andesites from Jaishi volcano and will consider the petrochemical characteristics of the magma concerned in volcanic activity. The authors should like to thank Professor Ken-ichiro AOKI of Tohoku University for providing trace element data for normalization. They also thank late Professor Naoki ONUMA of Ibaraki University who kindly determined Sr and Ba abundances by inductively coupled plasma-optical emission spectrometry.

Bulk Rock Chemistry

Andesite specimens used were collected from lava flows exposed at the southern

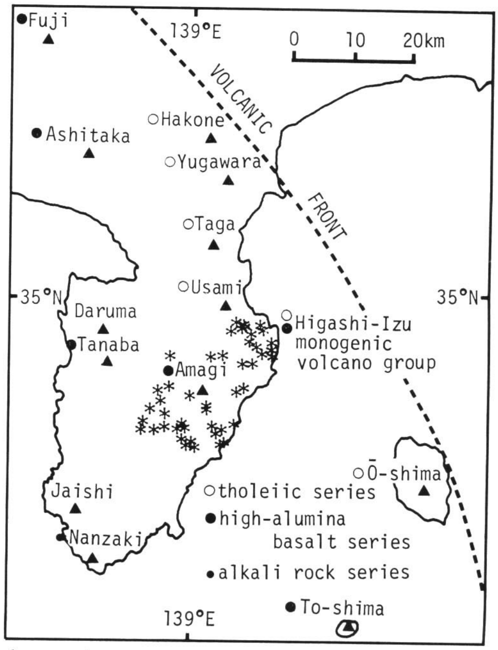

Fig. 1. Quarternary volcanoes in Izu Peninsula. Asterisks are vents of Higashi-Izu monogenetic volcano group (HAMURO, 1985).

foot and the northern flank of the volcano. They cover the lowermost to the uppermost flows constructing the principal part of the volcano. Brief description of the rocks were given formerly (TIBA *et al.*, 1982).

Trace element abundances in these andesites are shown in Table 1 together with major element analyses. Trace element contents were determined by X-ray fluorescence at Earthquake Research Institute, University of Tokyo.

Andesites analyzed have following abundance ranges: Rb 10–30 ppm, Sr 276–333 ppm, Ba 187–245 ppm, Y 25–39 ppm, Zr 84–104 ppm, V 158–228 ppm, Cr 46–124 ppm, Ni 17–44 ppm, Cu 29–59 ppm, Zn 48–67 ppm, Ga 14–17 ppm, Pb 1–7 ppm, Nb 4–5 ppm, Sc 21–28 ppm. Significant differences of Rb, Cr, Ni and Pb abundances are noted.

Considerations

For interpretation of evolutional course of the volcanic rocks, Pearce element ratio diagrams (PEARCE, 1968) are helpful as tested by NICHOLLS (1988) and RUSSELL & NICHOLLS (1988). Major and trace element plots on Pearce element diagrams (element/K-Si/K) are presented in Fig. 2a, b and c. Almost all element/K ratios except Rb/K and Pb/K ratios (Fig. 2b, c) have trends inclined to the left. Both Rb/K and Pb/K ratios show trends ascending to the left. Gentle inclinations of Mg/K and

Table 1.

ppm	1 MZ-92	2 MZ-91	3 MZ-90	4 MZ-89p	5 MZ-89d	6 MZ-86	7 MZ-58	8 81301	9 MZ-70
Rb	28	26	30	10	30	25	26	25	30
Sr	315	286	295	304	286	331	333	276	298
Ba	205	196	187	245	230	199	196	203	228
Y	26	26	28	39	34	39	26	25	30
Zr	92	84	94	104	100	94	92	91	101
V	216	229	198	191	210	158	200	217	168
Cr	55	74	124	65	94	46	75	117	66
Ni	26	26	36	24	28	17	31	44	24
Cu	59	49	56	55	56	29	54	49	34
Zn	67	64	55	57	58	49	60	62	51
Ga	17	16	15	15	15	14	16	15	14
Pb	6	5	1	1	7	2	5	<3	6
Nb	5	4	4	4	5	5	5	4	4
Sc	26	25	26	25	28	21	25	28	22
wt%									
SiO_2	53.87	55.19	56.37	54.56	56.63	57.39	55.27	56.03	57.08
TiO_2	0.83	0.81	0.76	0.75	0.74	0.77	0.89	0.85	0.82
Al_2O_3	17.00	15.48	16.61	17.27	16.12	18.08	15.30	17.13	17.37
Fe_2O_3	5.70	5.28	5.07	5.91	5.30	3.73	5.86	4.18	4.65
FeO	3.61	4.08	3.60	3.12	3.72	4.03	4.81	5.01	4.07
MnO	0.16	0.15	0.15	0.13	0.15	0.16	0.17	0.15	0.17
MgO	4.21	4.55	4.39	3.97	4.38	3.14	4.61	3.77	3.39
CaO	8.24	8.56	8.32	7.54	7.66	6.72	8.08	7.86	6.75
Na_2O	2.77	2.83	2.31	2.46	2.45	3.08	2.49	2.83	2.79
K_2O	1.26	1.21	1.20	0.93	1.35	1.24	1.18	1.21	1.63
H_2O+	0.52	0.47	0.31	1.06	0.57	0.33	0.39	0.37	0.31
H_2O-	1.61	1.26	0.83	2.26	0.92	0.94	0.81	0.76	0.61
P_2O_5	0.15	0.10	0.11	0.12	0.09	0.17	0.11	0.10	0.10
total	99.93	99.97	100.03	100.08	100.08	99.78	99.98	100.25	99.74

1. hypersthene-augite andesite (NSM 107169). 300 m northwest of Ochii, Minamiizu-machi, Shizuoka Prefecture. Tiba *et al.*, 1982.
2. hypersthene-augite andesite (NSM 107168). 300 m north by northwest of Ochii, Minamiizu-machi, Shizuoka Prefecture. Tiba *et al.*, 1982.
3. olivine-hypersthene-augite andesite (NSM 107167). 500 m north of Ochii, Minamiizu-machi, Shizuoka Prefecture. Tiba *et al.*, 1982.

4 & 5. pale- and dark-colored parts of olivine-hypersthene-augite andesite (NSM 107166). 600 m north of Ochii, Minamiizu-machi, Shizuoka Prefecture, Tiba *et al.*, 1982.

6. olivine-hypersthene-augite andesite (NSM 107163). 700 m north of Ochii, Minamiizu-machi, Shizuoka Prefecture. Tiba et al., 1982.
7. olivine-hypersthene-augite andesite (NSM 107135). 800 m north by northwest of Ōtoge, Matsuzaki-cho, Shizuoka Prefecture. Tiba *et al.*, 1982.
8. olivine-hypersthene-augite andesite (NSM 107186). 800 m northwest by west of Ōtoge, Matsuzaki-cho, Shizuoka Prefecture. Tiba *et al.*, 1982.
9. olivine-hypersthene-augite andesite (NSM 107147). 800 m west of Ōtoge, Matsuzaki-cho, Shizuoka Prefecture. Tiba *et al.*, 1982.

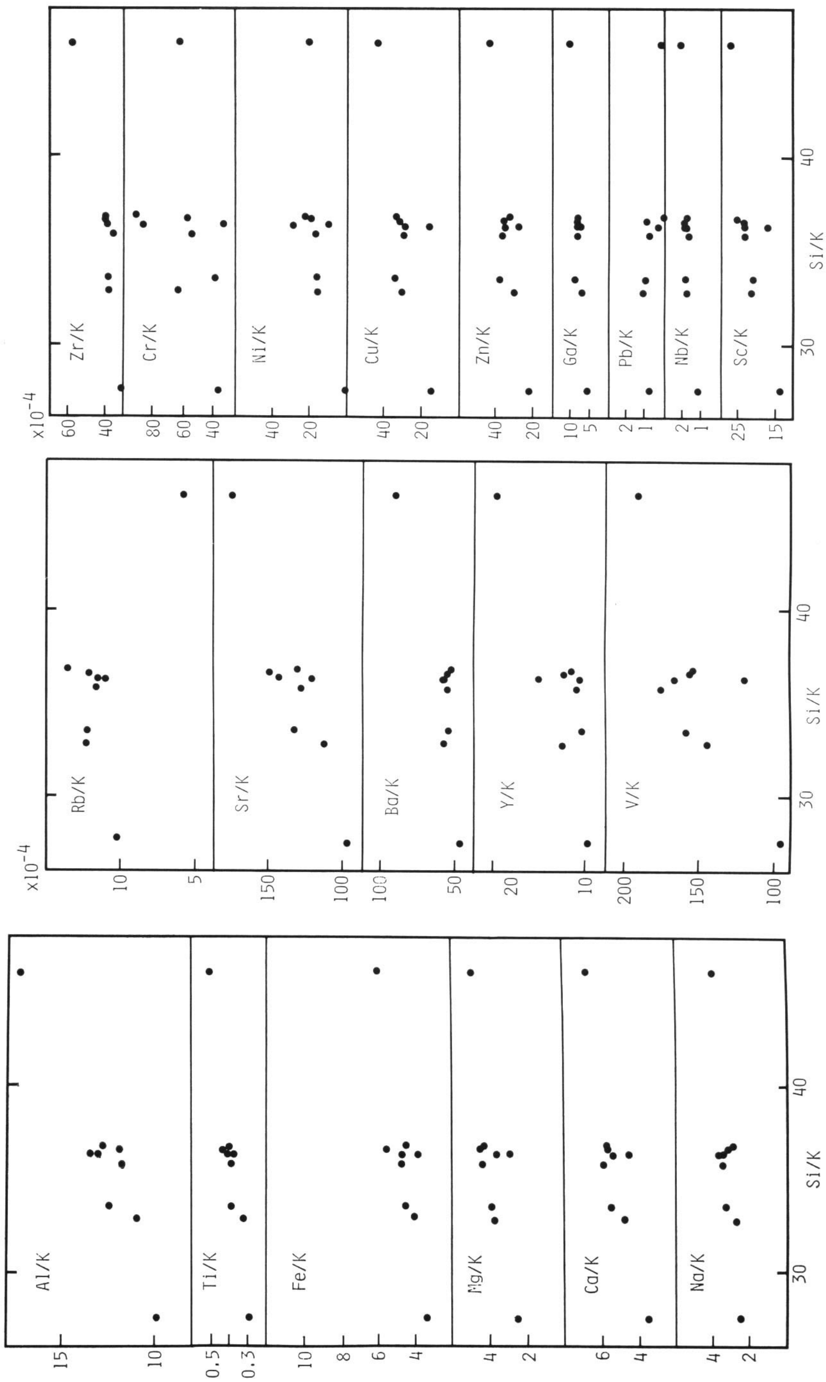

Fig. 2a, b, c. Element ratio diagrams.

Fe/K ratios and rather definite inclinations of Al/K and Ca/K associated with slight inclination of Na/K suggest that neither olivine nor orthopyroxene fractionation was more effective than plagioclase fractionation in yielding the chemical variation.

Incompatible element abundances are normalized to primitive mantle values and shown in Fig. 3 where the most incompatible element is set on the left. The andesites from Jaishi volcano are more enriched in K, Ba and Rb, and more depleted in Ti and Nb than the adjacent elements in Fig. 3. Such a normalized abundance pattern is common to calc-alkali andesites from the northeast Honshu (YOSHIDA & AOKI, 1984) and quite dissimilar from that of basanite from Nanzaki (AOKI *et al.*, 1987) about 10 km southeast of Jaishi volcano, though both volcanoes are at equal distances from the volcanic front (Fig. 1).

The pale-colored part of the banded andesite (analysis No. 3 in Table 1) is notably lower in Rb abundance than the others, but similar in abundances of other incompatible elements. This could be explained rather by local heterogeneity of the most incompatible element in the magma chamber than by contamination by some external material.

Sr/Ca-Rb/Ca diagram proposed by ONUMA (1980) has a potential ability for elucidating magma genesis and beautifully demonstrated that three older volcanoes (Okata, Fudeshima and Gyojanoiwaya) and the younger volcano (Ōshima) in Ōshima are formed by magmas derived from a common parental magma through clinopyroxene fractionation (ONUMA *et al.*, 1981). The andesites from Jaishi volcano, however, fall within a small area in this diagram in which the data obtained by ONUMA are added for confirmation (Fig. 4). In this diagram, any trend suggestive of degree of partial melting of the source material or crystallization fractionation of rock forming mineral(s)

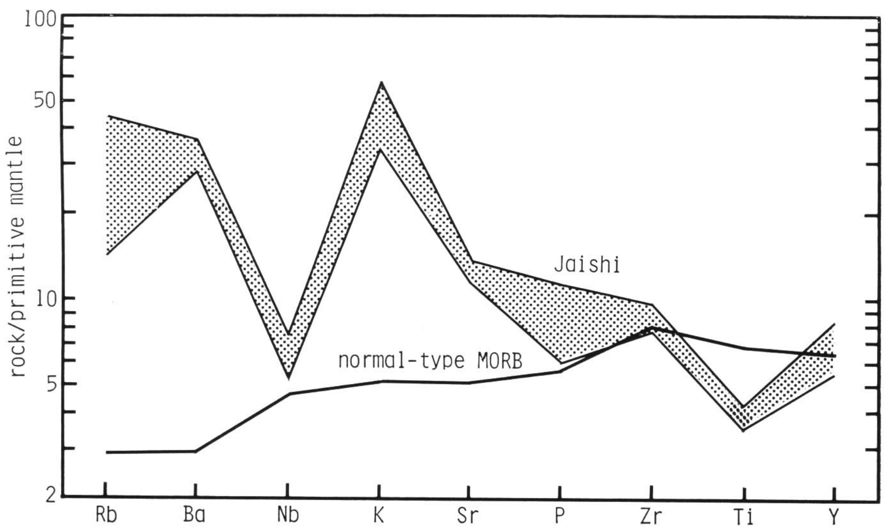

Fig. 3. Primitive mantle-normalized incompatible element pattern. Primitive mantle and normal-type MORB values are those in YOSHIDA and AOKI (1986).

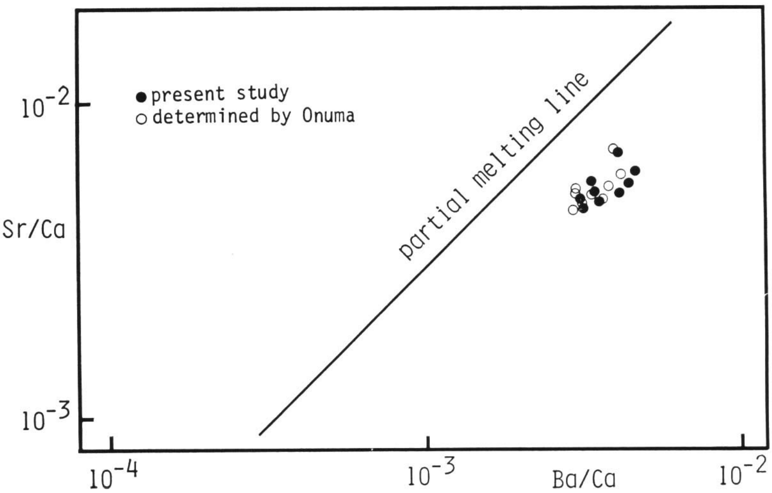

Fig. 4. Sr/Ca-Ba/Ca systematics. Partial melting line is that in ONUMA (1981).

is not found.

Major and trace element abundances presented herein imply that andesite lavas of Jaishi volcano have been extruded in a period after advanced crystallization of plagioclase and before any further evolution is accomplished in the magma chamber.

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