PETROCHEMISTRY AND MINERALOGY OF A K_2O -RICH MAFIC DIKE IN SHODO-SHIMA, KAGAWA PREFECTURE

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One of the so-called 'lamprophyre dikes' of Late Cretaceous age on Shodo-shima Island shows as high as 2.7 wt. % K_2O content and 2.6 K_2O/Na_2O ratio. The major-element composition corresponds to absarokite of the shoshonitic association. Discriminating the magma-type using the chemistry of 'immobile elements' and the mineralogy of plagioclase and clinopyroxene phenocrysts, however, revealed that the dike was not originally absarokitic (alkalic), but probably tholeiitic like the other 'lamprophyre dikes' nearby. The dike seems to have been altered chemically by alteration.

INTRODUCTION

Late Cretaceous dikes (so-called lamprophyres or spessartites; Sato, 1936) on Shodo-shima Island and the adjacent area seem to be usually of tholeiitic affinities (Ujike, 1977, 1978). Among these dikes, an altered one with a major element composition corresponding to absarokite of the shoshonitic* association (Joplin, 1968) has been found.

Petrogenesis of the K_2O -rich altered dike rock has been studied in detail to prove the possibility of an alkali igneous activity within the tholeiitic hypabyssal province. In this paper, the whole-rock chemistry of major elements and the contents of Rb, Sr, Y and Zr are reported. The mineral chemistry of plagioclase, clinopyroxene, actinolite, biotite and muscovite are described.

DESCRIPTION

Field characteristics

An altered mafic dike about 30 cm wide

intrudes a Late Cretaceous plutonic mass, which probably belongs to the Hiroshima granitoids, at a road-cut near Inodani Tunnel, Uchinomi-cho, Shodo-shima Island, Kagawa Prefecture (Fig. 1). The dike, one of the so-called lamprophyres (spessartites) of the Late Cretaceous age (Sato, 1936), strikes N25°E and dips 70°E. The interior of the dike is so intensely weathered that no rock fragments for petrologic examination can be obtained. The sample studied has come from one of the dark and compact chilled margins several centimeters wide. Plagioclase phenocrysts and their breakdown products can be seen easily by the naked eye especially on the weathered surface.

Petrography

The dike rock consists of about 20% large crystals and 80% matrix. The large crystals are clear and euhedral calcic plagioclase only partly replaced by muscovite ~6%; euhedral clinopyroxene con-

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* 'Shoshonitic' is included under 'alkalic' unless otherwise noted in this paper, although shoshonitic and alkali basalt associations are better treated separately (Joplin, 1968).

Fig. 1. Locality of K_2O -rich mafic dike.

siderably replaced by fibrous aggregates of actinolite or uraltite, which in turn is partly altered to biotite $\sim 8\%$; coarse-grained actinolite $\sim 6\%$; and a trace of corroded quartz xenocryst. Replacement of plagioclase by muscovite is developed in the sample only slightly more than in the adjacent dikes. Some of the coarse actinolites replace euhedral crystals resembling olivine in outline. The rest of the actinolites seem to fill vesicles.

The matrix is so fine-grained that identification of minerals is very difficult or impossible for a considerable portion in thin section. Using a combination of microscopic and electron probe microanalysis

techniques, the matrix materials were, nevertheless, identified with certainty. They are: laths of plagioclase, flakes of biotite, needles of actinolite, minute plates of ilmenite and small patches of pyrite. Biotite seems to be the most abundant. Small amounts of chlorite and clay minerals may be present. Alkali feldspars cannot be detected anywhere in spite of the high K_2O concentration of the rock. The matrix is cut by narrow veinlets of carbonates, but rarely.

Phenocrystic plagioclase and clinopyroxene must be of igneous origin. On the other hand, most of the other minerals, excluding plagioclase laths, in the matrix

appear to be alteration products. It is obvious that the sample with plagioclase phenocrysts cannot be named lamprophyre on the basis of definition (p 509 in Carmichael *et al.*, 1974; Rock, 1977). The dike rock in question should be properly called an altered basalt or dolerite.

PETROCHEMISTRY

The chemical composition of the dike rock is given in Table 1. Major element concentrations were determined by conventional wet chemical methods and atomic absorption techniques. Analysis of the trace elements, Rb, Sr, Y and Zr was carried out by X-ray fluorescence techniques using the same equipment and methods described by Terashima (1977). The geochemical standard rock samples, PCC-1, BCR-1, AGV-1, GSP-1, G-2 and JB-1 were used for calibration. The trace element data on the other dike rocks (so-called lamprophyres) on Shodo-shima Island are given in Appendix 1.

As shown in Fig. 2, the sample (solid circle), like the absarokites (crosses), has a

Table 1. Chemical composition (major oxides, wt. %), CIPW norm and trace element abundance (ppm) of K₂O-rich mafic dike.

SiO ₂	45.44	Or	16.0	Rb	121	} ppm
TiO ₂	0.80	Ab	8.0	Sr	216	
Al ₂ O ₃	17.57	An	35.3	Y	20	
Fe ₂ O ₃	1.12	Ne	0.5	Zr	72	
FeO	7.94	Wo	4.2			
MnO	0.18	Di	En	Rb/Sr	0.56	
MgO	10.77		Fs	K/Rb	190	
CaO	9.31	Ol	Fo	K ₂ O/Na ₂ O	2.57	
Na ₂ O	1.05		Ph	ΣFeO/MgO	0.83	
K ₂ O	2.70	Il	1.5			
H ₂ O+	2.86	Mt	1.6			
H ₂ O-	0.37	Ap	0.3			
F ₂ O ₆	0.12					
Total	100.23					
				ΣFeO	38.1	
				MgO	45.9	
				Na ₂ O+K ₂ O	16.0	

composition falling within the alkalic field of Macdonald & Katsura (1964). It differs greatly from the adjacent dikes (open circles) in terms of the alkali-silica diagram.

Plots of discriminant functions, F₁, F₂ and F₃ (Pearce, 1976) are shown in Fig. 3. Analyses with (CaO+MgO) between 12 and 20 wt.% are cited selectively from Ujike (1977) for comparison. The composition of the sample is plotted within the field of shoshonites, whereas that of the other dike rocks lie in the field of 'calc-alkali basalts'* in Fig. 3. Nepheline is present in the CIPW norm composition of the sample. The K₂O and Al₂O₃ contents are high for the SiO₂ content. The K₂O/Na₂O ratio (= 2.6) is very high as compared to that of the so-called lamprophyre dikes in the area which ranges within 0.3–0.6 (Ujike, 1977). The sample correspond to absarokite of the shoshonitic association (Joplin, 1968; Mackenzie & Chappell, 1972; Jakeš & White, 1972).

The K/Rb ratio (=190) is slightly lower for the K₂O content compared with

Fig. 2. (Na₂O+K₂O)-SiO₂ plot for sample and related rocks. Solid circle: K₂O-rich mafic dike. Open circles: Mafic to intermediate dikes (so-called lamprophyres) popular on Shodo-shima Island (Ujike, 1977). Crosses: Absarokites (Jaques, 1976; Joplin, 1968; Mackenzie & Chappell, 1972). Fields of magma type (Macdonald & Katsura, 1964): ALK=alkalic, and TH=tholeiitic.

* This is not in conflict with the author's argument (Ujike, 1977) that the dikes are high-alumina quartz tholeiitic, since 'calc-alkali basalts' used by Pearce (1976) includes all volcanic arc basalts other than shoshonitic and low-K₂O tholeiitic associations.

Fig. 3. Discriminant function diagrams (Pearce, 1976) for sample and related rocks. A: F_2 - F_1 plot. B: F_2 - F_3 plot. F_1 , F_2 and F_3 : Discriminant functions separating the magma types after Pearce (1976). Fields of magma type: WPB='within-plate' basalts, SHO=shoshonites, CAB=calc-alkali basalts, LKT=island-arc tholeiites, and OFB=ocean-floor basalts. Other abbreviations as in Fig. 2.

Fig. 4. Geochemical magma type discrimination diagrams (Winchester & Floyd, 1976) for sample and related rocks. A: TiO_2 - $\text{Zr}/\text{P}_2\text{O}_5$ plot. B: P_2O_5 - Zr plot. Crosses: Mafic rocks of shoshonitic association (Gill, 1970; Keller, 1974; Mackenzie & Chappell, 1972). Other abbreviations as in Fig. 2.

the main trend average (Shaw, 1968), but well within the limits of 160 and 300 for normal igneous rocks by Taylor (1965; quoted by Shaw, 1968). Jakeš & White

(Table 2, 1972) reported K/Rb ratio of 200 for the shoshonitic association in their review paper. This estimation may be too low for the representative value for abs-

arokite in the light of recent determinations (e.g. Jaques, 1976; Keller, 1974). It can be safely said, however, that the K/Rb ratio of the sample is not unusually low for absarokite.

It is shown recently that some elements such as Ti, P, Zr and Y are least mobile during hydrothermal alteration and metamorphism and that magma-types can be distinguished for altered mafic igneous rocks of unknown origin using these elements (Cann, 1970; Pearce & Cann, 1973; Smith & Smith, 1976; Winchester & Floyd, 1976). In Fig. 4, composition of the sample is plotted on TiO₂-Zr/P₂O₅ and P₂O₅-Zr diagrams (Floyd & Winchester, 1975; Winchester & Floyd, 1976) to discriminate the magma-type. Compositions of the sample (solid circle) and the other dike rocks (open circles) lie in the tholeiitic field, and the rocks of shoshonitic association (crosses) lie in the alkalic field, especially in Fig. 4-B. In spite of the previous argument that the sample is absarokitic in composition, it is apparent that the magma intruded was not alkalic but tholeiitic, or at least 'subalkaline' (p. 461, Winchester & Floyd, 1976) like the other so-called lamprophyre dikes on Shodo-shima Island. The high-K₂O concentration might be due to alteration.

In Fig. 4, the magma-type of the shoshonitic rocks cannot be distinguished from the TiO₂-Zr/P₂O₅ diagram because of their poverty in TiO₂ and Zr contents. The boundary curves were settled originally on the basis of analyses of mafic rocks from continental and oceanic regions (Floyd & Winchester, 1975; Winchester & Floyd, 1976). There are doubts about their applicability to rocks from the island arcs and the continental margins. The diagrams

in Fig. 4 are, however, effective for the present purpose of showing the affinity between the sample and the other dike rocks on Shodo-shima Island and their dissimilarity to the shoshonitic rocks in terms of magma-type.

MINERALOGY

Chemical compositions of minerals were determined by automated electron probe microanalysis (Okumura & Soya, 1976). The numbers of cations were calculated by computer, assuming all Fe as Fe²⁺.

Plagioclase

Plagioclase is calcic (up to An₉₃) and relatively poor in chemical zoning except at the extreme outer edges of the crystals (Table 2). The edge seems to have an An percent as low as An₈₅ according to the content profile techniques (Okumura *et al.*,

Table 2. Representative microprobe analyses of plagioclase.

Position	1 P-C	2 P-M	3 P-R	4 G-C	5 G-R
GSJ-EP No.	772890	772889	772888	772891	772892
SiO ₂	45.75	45.20	46.84	46.68	49.39
TiO ₂	0.02	0.00	0.05	0.00	0.03
Al ₂ O ₃	33.78	34.50	33.10	33.28	31.60
FeO*	0.21	0.18	0.34	0.33	0.46
MnO	0.00	0.00	0.01	0.03	0.00
MgO	0.10	0.08	0.14	0.14	0.09
CaO	17.67	18.50	16.81	17.35	15.51
Na ₂ O	1.35	0.85	2.02	1.63	2.69
K ₂ O	0.04	0.03	0.07	0.05	0.08
Total	98.92	99.34	99.37	99.49	99.85
Numbers of cations (O=8)					
Si	2.130	2.098	2.169	2.160	2.264
Al	1.854	1.888	1.807	1.815	1.708
Ti	0.001	0.000	0.002	0.000	0.001
Fe*	0.008	0.007	0.013	0.013	0.018
Mn	0.000	0.000	0.001	0.001	0.000
Mg	0.007	0.005	0.009	0.009	0.006
Ca	0.882	0.920	0.834	0.860	0.762
Na	0.122	0.077	0.181	0.146	0.239
K	0.003	0.002	0.004	0.003	0.005
Atom %					
Ca	87.6	92.1	81.8	85.2	75.8
Na	12.1	7.7	17.8	14.5	23.7
K	0.3	0.2	0.4	0.3	0.5

Position: P=phenocryst, G=groundmass, C=core, M=margin, and R=rims. GSJ-EP No.: Analysis number by the automated electron probe microanalyzer at Geol. Dept., Geol. Surv. Japan. * All Fe as Fe²⁺.

1975). The concentration gradient is so steep near the edge because of quenching of the magma that the quantitative analysis cannot be made with any certainty. In the groundmass plagioclase, the An content varies monotonously from the core to the edge, whereas, in the phenocrystic plagioclase it has a maximum at the mantle immediately surrounding the broad core. The compositional variation is very smooth and continuous across the crystal in most parts of the phenocryst. This may indicate that the magma has never experienced any abrupt change in physical and chemical conditions before the intrusion. The high K_2O concentration of the sample seems to be not due to contamination of magma after the phenocrystic stage of magmatic ascent by such materials as biotite.

Absarokites are characterized by the absence of phenocrystic plagioclase, while

shoshonites may or may not contain plagioclase of labradorite to andesine composition as phenocrysts (e.g. Jaques, 1976; Joplin, 1968). The presence of calcic plagioclase phenocrysts suggests that the dike rock in question does not belong to the shoshonitic association.

In Fig. 5, K and Fe contents seem to increase slightly with decreasing $Ca/(Ca+Na)$ ratio in plagioclase. Mg content also increases with decreasing $100 \times Ca/(Ca+Na)$, at least, at ratios greater than 80. $Mg/(Mg+Fe)$ ratio shows little variation (0.3–0.5) in most plagioclase analyses, but it shows a weak tendency to become smaller with decreasing An content.

Fe and Mg might be introduced in plagioclase as $Ca(Mg, Fe)Si_3O_8$ component, especially in a crystal rapidly grown by quenching of the magma (Bryan, 1974; Hodges & Papike, 1976). As shown in Fig.

Fig. 5. Cations- $100 \times Ca/(Ca+Na)$ plots for plagioclase. Solid circles: Phenocrysts. Open circles: Groundmass. Arrows: Zoning from core (C) to rim (R) through margin (M), whose analyses are in Table 2.

5, the groundmass plagioclases contain somewhat more Fe than the phenocrysts in a range of $100 \times \text{Ca}/(\text{Ca} + \text{Na}) = 85\text{--}90$ where most plots in the figure represent the compositions of cores of the two generations. The different conditions of crystallization appear to be reflected by their difference in Fe content as expected, although they are comparable in An content. On the other hand, the rim compositions of the phenocrysts and groundmass are similar with respect to Fe content at $100 \times \text{Ca}/(\text{Ca} + \text{Na})$ smaller than 85. This is in harmony with the fact that they must have formed simultaneously after magmatic intrusion.

Clinopyroxene

Phenocrystic clinopyroxene is endiopside or augite in composition (Table 3 and Fig. 6). They are unlike the phenocrystic clinopyroxenes in alkalic igneous rocks in the sense that they contain less Ti, Al and Na. Chemical variation is relatively large among different crystals but not within each crystal.

Table 3. Representative microprobe analyses of clinopyroxene.

	1	2	3	4	5
GSJ-EP No.	772879	772877	772884	772853	772919
SiO ₂	52.38	52.14	52.96	52.87	52.06
TiO ₂	0.37	0.55	0.63	0.46	0.63
Al ₂ O ₃	2.92	2.69	2.26	2.02	1.65
FeO*	6.02	6.16	7.42	8.27	12.60
MnO	0.19	0.18	0.25	0.25	0.32
MgO	17.17	16.01	16.05	15.92	13.89
CaO	20.60	21.85	20.56	20.15	18.75
Na ₂ O	0.20	0.17	0.20	0.18	0.21
K ₂ O	0.02	0.00	0.01	0.01	0.00
Total	99.87	99.75	100.34	100.13	100.11
Numbers of cations (O=6)					
Si ^{IV}	1.922	1.924	1.945	1.951	1.955
Al ^{VI}	0.078	0.076	0.056	0.049	0.045
Al	0.048	0.041	0.042	0.039	0.028
Ti	0.010	0.015	0.017	0.013	0.018
Fe*	0.185	0.190	0.228	0.255	0.396
Mn	0.006	0.006	0.008	0.008	0.010
Mg	0.939	0.881	0.878	0.875	0.777
Ca	0.910	0.864	0.909	0.797	0.755
Na	0.014	0.012	0.015	0.013	0.015
K	0.001	0.000	0.001	0.001	0.000
Atom %	Mg	48.4	45.4	45.7	45.2
	Fe*+Mn	9.8	10.1	12.2	13.6
	Ca	41.8	44.5	42.1	41.2

Abbreviations as in Table 2.

The variation follows the characteristic of Ca-rich clinopyroxenes from tholeiitic layered intrusions on the pyroxene quadrilateral. Bushveld Ca-rich pyroxene trend (Atkins, 1969) is cited and shown for comparison in Fig. 6.

Fig. 6. Ca-($\Sigma \text{Fe} + \text{Mn}$)-Mg plot for clinopyroxene, compared with the Bushveld trend.

Fig. 7. Mineralogical magma type discrimination diagrams for clinopyroxene.

A: Si-Al plot (Maruyama, 1976). B: Al_2O_3 - ΣFeO plot (Takasawa & Hirano, 1977). Open circles: See text. Fields of magma type: ALK=alkalic, TH=tholeiitic, and TR=transitional or undefinable.

Two diagrams for magma-type discrimination are given in Fig. 7 using the analyses of unaltered clinopyroxene phenocrysts. Boundary curves for tholeiitic and alkalic fields are drawn in the Al-Si plot (Fig. 7-A) after Maruyama (1976) who improved the efforts of Kushiro (1960). All the analyses, including those with $\text{Fe}/(\text{Fe} + \text{Mg})$ greater than 0.25 (open symbols) which should be omitted in the discrimination strictly (p. 192 in Maruyama, 1976) lie within the field of clinopyroxenes from tholeiitic rocks.

A discrimination method for magma-type has been proposed by Takasawa & Hirano (1977) using Al_2O_3 - ΣFeO relation of clinopyroxenes present. The data should be examined as a group in this method; the compositional trend, not the position of individual plots, is significant for the discrimination. As shown in Fig. 7-B, the Al_2O_3 content decreases with increasing ΣFeO concentration, suggesting that a magma from which the clinopyroxenes

crystallized was 'non-alkaline' (Takasawa & Hirano, 1977).

Actinolite

Actinolites are nearly colorless and show a wide chemical variation even in a single thin section as shown in Table 4. The ranges in composition are as follows: $\text{Si}=7.54\text{--}7.97$, $\Sigma\text{Al}=0.05\text{--}0.68$, $\text{Al}^{\text{VI}}=0.02\text{--}0.33$, $\text{Ti}=0.00\text{--}0.02$, $\Sigma\text{Fe}=0.90\text{--}1.62$, $\text{Mn}=0.03\text{--}0.06$, $\text{Mg}=3.11\text{--}4.02$, $\text{Ca}=1.88\text{--}1.98$ and $\text{Na} + \text{K}=0.01\text{--}0.12$ on the basis of 23 oxygens, and $\text{Mg}/(\text{Mg} + \Sigma\text{Fe} + \text{Mn})=0.65\text{--}0.81$. More detailed microprobe examination would reveal a wider compositional range. This may be an indication that equilibrium was not attained, or attained only locally, in the crystallization of actinolite. Specific correlation cannot be recognized between the compositions and the mineralogic settings of actinolites (that is, uraltic, coarse-grained, vesicle-filling, etc.).

Table 4. Representative microprobe analyses of actinolite, biotite and muscovite.

	1	2	3	4	5	6
	Actinolite			Biotite		Muscovite
GSJ-EP No.	772854	772871	772874	782525	782523	780826
SiO ₂	55.39	53.90	52.06	39.25	39.90	45.81
TiO ₂	0.06	0.12	0.06	0.40	1.33	0.01
Al ₂ O ₃	0.92	3.33	4.55	14.88	14.79	36.70
FeO*	10.31	11.45	13.35	13.53	13.50	0.63
MnO	0.41	0.27	0.37	0.11	0.14	0.02
MgO	17.71	15.90	14.39	16.81	15.94	0.65
CaO	12.57	12.62	12.35	0.09	0.08	0.04
Na ₂ O	0.08	0.24	0.35	0.04	0.06	0.13
K ₂ O	0.02	0.10	0.13	8.88	8.35	11.04
Total	97.47	97.93	97.61	93.99	94.09	95.03
Numbers of cations (O=23)				(O=22)		
Si	7.893	7.692	7.539	5.847	5.908	6.099
Al	0.107	0.308	0.461	2.153	2.092	1.901
Al	0.047	0.253	0.316	0.461	0.490	3.859
Ti	0.006	0.013	0.006	0.045	0.148	0.001
Fe*	1.228	1.366	1.617	1.686	1.671	0.070
Mn	0.049	0.033	0.045	0.013	0.018	0.003
Mg	3.761	3.381	3.105	3.732	3.518	0.129
Ca	1.919	1.929	1.917	0.014	0.013	0.006
Na	0.023	0.065	0.098	0.013	0.017	0.033
K	0.004	0.018	0.023	1.688	1.578	1.876
100X Mg/(Mg+Fe*)	75.4	71.2	65.8	68.9	67.8	64.9

Abbreviations as in Table 2.

Biotite

Compositions of biotites straddle the boundary between the fields of biotite and phlogopite (Deer *et al.*, 1962): The Mg/(Mg + ΣFe) ratio is in a range of 0.66–0.69. Biotite analyses often show considerable deficiencies of the oxide's total and K₂O, probably due to weathering. The data with the highest K₂O content are listed in Table 4.

Muscovite

A secondary muscovite (sericite) partly replacing a plagioclase phenocryst was analysed and the result is given in Table 4.

DISCUSSION

On the basis of petrographical, chemical and mineralogical data, we cannot escape the conclusion that the whole-rock composition of the altered dike near Inodani Tunnel does not represent the magmatic composition. The magma must have been tholeiitic, or at

least not alkalic, compositionally. The dike must have become absarokitic in major-element composition through some alteration process which caused the high-K₂O content. The alteration seems to have been operative restrictedly only on the dike in discussion and not regionally, as judged by the low K₂O content of the adjacent dikes (so-called lamprophyres). The mineralogy of the alteration products indicates that a hydrous fluid phase played an important role in the process.

Metasomatism due to hydrothermal fluids is expected to be accompanied by a sharp decrease in the K/Rb ratio according to Shaw (1968). The fact that the sample shows a normal K/Rb ratio may be taken as an evidence against the hydrothermal alteration origin hypothesis for the high-K₂O concentration.

Nevertheless, the present author considers that it was hydrothermal or deuteric alteration that introduced much K₂O into the dike. Although a concrete process is far from certain, the process might be characterized by the alkali exchange reaction between the rock and a hydrous fluid, taking into account the relatively low Na₂O content (=1.05 wt. %) in contrast with the 1.8–3.5 wt. % Na₂O of the so-called lamprophyre dikes (Ujike, 1977).

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香川県小豆島のカリウムに富む苦鉄質岩脈の岩石化学と鉱物学

氏 家 治

後期白亜紀に貫入した標記岩脈岩の主成分組成は、SiO₂=45.4 wt. %, K₂O=2.7 wt. %, K₂O/Na₂O=2.6 などであって、アルカリ岩系ことにシヨシヨナイト アソシエーションのアブサロカイトに相当する。ところが、
変成作用や変質作用によって移動し難い Ti, P および Zr の含有量から判断すると、マグマ本来の組成は、非
アルカリ岩的であったと思われる。斑晶をなす斜長石と単斜輝石の組成も、アルカリ岩的でなく、ソレアイト
的である。本岩脈は、局所的な変質作用を受けて、現在の組成に変化したのであろう。

(地名)

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APPENDIX I

Some dike rocks on Shodo-shima Island were analyzed by XRF for Rb, Sr, Y and Zr at the same time as the K₂O-rich dike rock of this paper, using the rest of rock powders analyzed chemically by Ujike (1977). The results are given in Table A-1.

Table A-1. Trace element abundances (ppm) of Late Cretaceous dike rocks (so-called lamprophyres) on Shodo-shima Island.

Sample*		920	918	917	911	907	915	810	916
Rb		27	77	58	23	32	32	42	89
Sr		366	355	375	400	379	351	405	368
Y		18	22	26	22	20	23	24	22
Zr		72	101	103	88	107	114	158	126
Ujike(1977)	SiO ₂	49.19	51.38	51.57	51.84	51.99	54.86	59.18	59.20
in wt. %	TiO ₂	1.02	1.01	1.08	1.19	1.34	1.19	1.10	0.86
	P ₂ O ₅	0.21	0.20	0.20	0.18	0.30	0.20	0.31	0.22

* Numbers as in Ujike (1977).