報 文

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Petrochemistry of Minami–ōsumi Granite in the Uchinoura Area, Kyushu, Japan

By

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Abstract

Granites in the southern area of the Osumi peninsula are divided into two, after potassium–argon age, despite of the similarity of geologic and petrographic characters. In the present paper, petrochemical characters of the northern Uchinoura area are described.

It is concluded that "Uchinoura type" granite bears common petrochemical features to the Outer Zone granite of Southwest Japan, but is somewhat unique as shown in various diagrams, apart from other Minami–ōsumi granite.

Scope of the present paper

In the southern area of the Osumi peninsula, there are exposed widely granitic rocks which are intruded into "Shimanto group," late Mesozoic or early Tertiary. They are similar and closely related to each other in geologic and petrographic characters and have been believed to belong to the same plutonism. Recently potassium–argon age determination was carried out on three samples from these granitic rocks. The results are not the same; about 14 million years for the sample from Mizushiri in the northern part of the Minami–ōsumi area (southern Osumi peninsula) and about 21 million years for the sample from Manguro and Tashiro in the southern part (MILLER, SHIBATA & KAWACHI, 1962 and KAWANO & UEDA, 1965).

Therefore, petrographic differences between the northern and southern parts are hoped to be pursued. But, the difference and boundary corresponding to the different isotopic ages are not yet clear. In the present paper, the writers intend to elucidate petrochemical character of the northern part of the Minami–ōsumi granite, especially in the northern Uchinoura district.

Minami–ōsumi granite in the Uchinoura district

The Minami–ōsumi granite in this district is composed mainly of adamellite, granodiorite, granite in narrow sense, tonalite and aplite. Among them adamellite and granodiorite are most dominant, on which chemical analysis was carried out. The granite is intruded into shale and sandstone formation of the Shimanto group discordantly with sharp contact, giving thermal metamorphism to the latter. Biotite clot is contained abundantly throughout the rock. Inclusions are not so abundant but inclusions derived from pelitic metamorphic rocks such as muscovite schist, garnet–bearing biotite schist, spinel–corundum rock, sillimanite–andalusite–muscovite schist, etc. are conspicuous. Tourmaline is a common accessory constituent of the aplite and pegmatite.

After OBA (1960), there are three facies in the Minami–ōsumi granite; hornblende–rich granodiorite, dark–colored fine–grained biotite granodiorite and light–colored granodiorite. Granitic rocks in the northern Uchinoura district are mostly light–colored granodiorite, probably referred to "Uchinoura type" after OBA (1963).

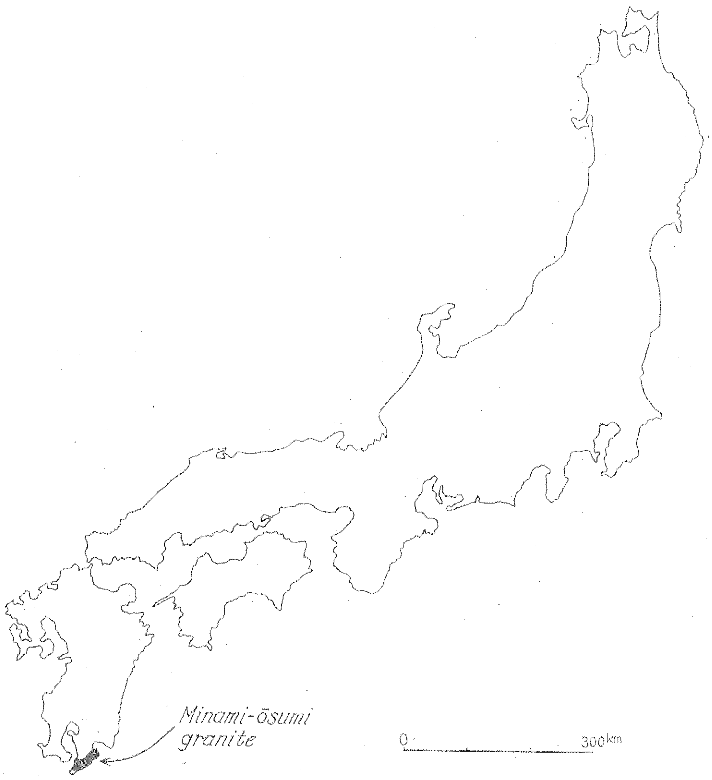

Fig. 1 Index to the Minami-ōsumi granite area

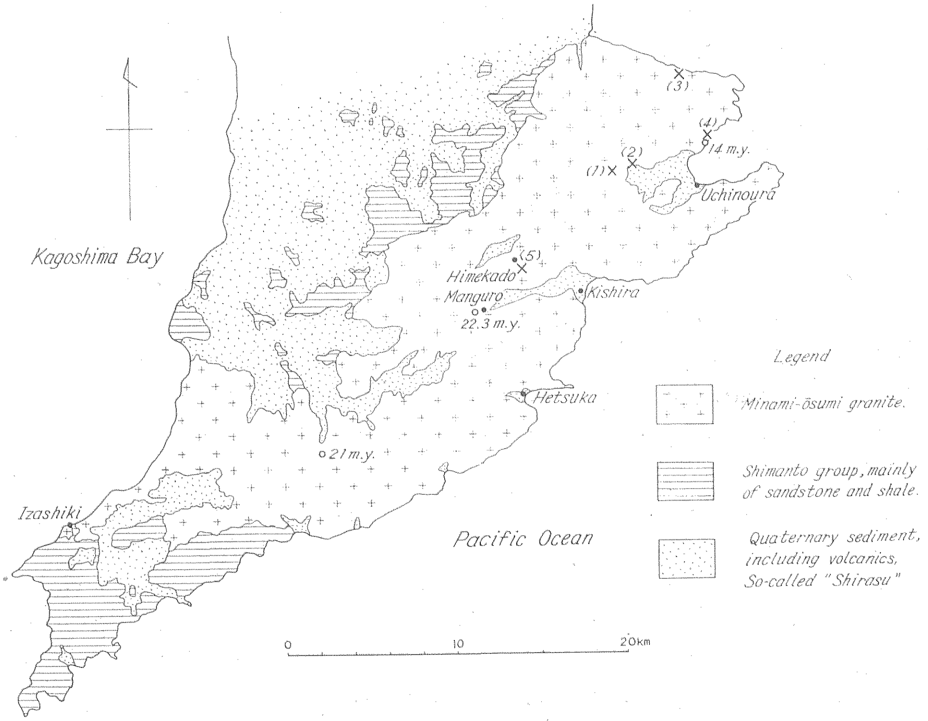

Fig. 2 Geologic map of the Minami-ōsumi granite area and sample localities for chemical analysis and potassium-argon age determination
(Key: Cross……Sample locality for chemical analysis.
Open circle……Sample locality for potassium-argon age determination.)

Description of the analysed samples

(1) Porphyritic medium-grained granodiorite (TN62030801)

Sakamoto, Uchinoura-cho, Kimotsuki-gun, Kagoshima pref.

It is light-colored, non-gneissose, homogeneous, to the naked eye. Under the microscope, however, it has somewhat complicated structure in which porphyritic crystals of plagioclase are embedded in fine-grained matrix composed mainly of plagioclase, quartz, microcline and biotite. Small quantities of apatite, iron ore and zircon are contained, too. Biotite is flaky, 0.5–1.0 mm across, giving pleochroism; X: colorless or pale brown, Y, Z: reddish brown. Porphyritic plagioclase is idiomorphic, long prismatic, 0.5–6.0 mm long, and zoned repeatedly. Its composition is oligoclase on its rim. Fine-grained plagioclase is hypidiomorphic and oligoclase in composition, too. Microcline is allotriomorphic, 2–3 mm across, and often gets larger in phenocrystic form.

(2) Porphyritic adamellite (TN62030711)

Magome, Uchinoura-cho, Kimotsuki-gun, Kagoshima pref.

It is similar to (1), but contains phenocrystic microcline as well as relatively fine-grained microcline in the matrix more abundantly.

(3) Porphyritic medium-grained granodiorite (TN62030706)

Igatani, Kōyama-cho, Kimotsuki-gun, Kagoshima pref.

Quite similar to (2), but phenocrystic microcline is not so conspicuous as (2).

(4) Porphyritic adamellite (TN62022403A)

Tarumizu, Uchinoura-cho, Kimotsuki-gun, Kagoshima pref.

It is similar to (3), but microcline increases in phenocryst as well as in the matrix. Phenocrysts of plagioclase, 2–3 mm across, are contained, too.

(5) Adamellite (TN62022001)

Himekado, Uchinoura-cho, Kimotsuki-gun, Kagoshima pref.

It is similar to (4), but is coarser-grained and porphyritic character is not so conspicuous. Colorless hornblende is rarely contained in the core of biotite crystal or center of biotite clot.

(6) Porphyritic medium-grained adamellite (TN64030405)

Hetsuka, Uchinoura-cho, Kimotsuki-gun, Kagoshima pref.

It is similar to (3), except more abundant development of phenocrystic microcline, 3–4 mm across. Biotite is flaky, 0.2–1.0 mm; plagioclase, 0.5–0.8 mm; quartz, 0.3–0.8 mm across.

Chemical composition of the Minami-ōsumi granite, Uchinoura type

(a) Major constituents

Features of the major constituents of the Uchinoura type-granodiorite and adamellite are mostly common to the "Outer Zone granite" of Southwest Japan, such as K_2O surpassing Na_2O or FeO surpassing CaO.

The Uchinoura type is relatively homogeneous in chemical character. Its variation is restricted to a narrow and unique field among the Minami-ōsumi granite in various diagrams. As seen in Fig. 3, its Differentiation Index ranges narrowly from 71 to 74. In Fig. 4, FeO:Na_2O+K_2O:MgO diagram, its points fall approximately on a line comparable to the calc-alkali volcanic rocks' average, from a point, FeO:Na_2O+K_2O:MgO = 32:56:12 to another point, 42:43:15. In Fig. 5, normative Q:Or:Ab, its points fall in a narrow area, in the vicinity of a point, Q: Or: Ab = 40:30:30, which lies slightly on Ab–poorer side than other Minami–ōsumi granite. Some of these features correspond to the petrographic characters; for instance, relative abundance of K_2O coinsides well with the predominance of potassium feldspar which occurs replacing the plagioclase as well as in phenocrystic form.

Table 1 Chemical composition of the granodiorite and adamellite of Uchinoura type—Major component, in weight percentage

	(1)	(2)	(3)	(4)	(5)	(6)	(A)	(B)
SiO_2	66.76	66.90	67.34	67.78	67.60	66.76	67.28	69.17
TiO_2	.66	.66	.59	.64	.54	.70	.62	.39
Al_2O_3	15.40	15.73	16.05	15.29	15.48	15.73	15.59	15.00
Fe_2O_3	1.12	.59	.54	.42	.80	.79	.69	1.05
FeO	3.27	3.66	3.59	3.90	2.84	3.66	3.45	2.48
MnO	.06	.08	.08	.08	.06	.09	.07	.10
MgO	1.50	1.52	1.43	1.45	1.35	1.58	1.45	1.15
CaO	2.98	3.07	3.03	2.83	3.04	3.30	2.99	3.15
Na_2O	2.84	2.73	2.52	2.18	2.76	3.05	2.61	3.45
K_2O	3.69	3.45	3.42	3.94	3.60	2.92	3.62	3.01
P_2O_5	.15	.12	.15	.11	.08	.14	.12	.13
$H_2O(+)$	1.33	1.25	1.01	1.21	1.19	.66	1.20	.74
$H_2O(-)$	.16	.18	.18	.16	.18	.23	.17	.30
Total	99.92	99.94	99.93	99.99	99.52	99.61	99.86	100.12
		(Norm)						
Q	25.98	26.76	28.80	29.46	27.96	26.27	27.85	27.97
C	1.63	2.14	3.06	2.55	1.84	1.55	2.57	0.64
Or	21.70	20.59	20.03	23.37	21.15	17.25	21.37	17.81
Ab	24.12	23.07	21.50	18.35	23.59	22.50	22.03	29.20
An	13.91	14.46	14.19	13.35	14.19	16.40	13.95	14.77
Sal. tot.	87.34	87.02	87.58	87.08	88.73	83.97	87.77	90.39
En	3.71	3.81	3.61	3.61	3.11	3.94	3.61	2.86
Fs	4.22	5.28	5.41	5.80	3.83	4.70	4.87	3.22
Mt	1.62	.93	.70	.70	1.16	1.83	1.00	1.53
Il	1.21	1.21	1.06	1.21	1.06	1.34	1.18	.74
Ap	.34	.34	.34	.34	.34	3.36	.30	.30
Fem. tot.	11.10	11.57	11.12	11.66	9.50	15.17	10.96	8.65
Tot.	98.44	98.59	98.70	98.74	98.23	99.14	98.73	99.04

(1)–(6), See the text, "description of the analysed samples."
(A) Average of (1)–(5).
(B) Average of granitic rocks in Japan (SiO_2>55%) after HATTORI et al. (1960)
Analyst: Masaki KAWANO

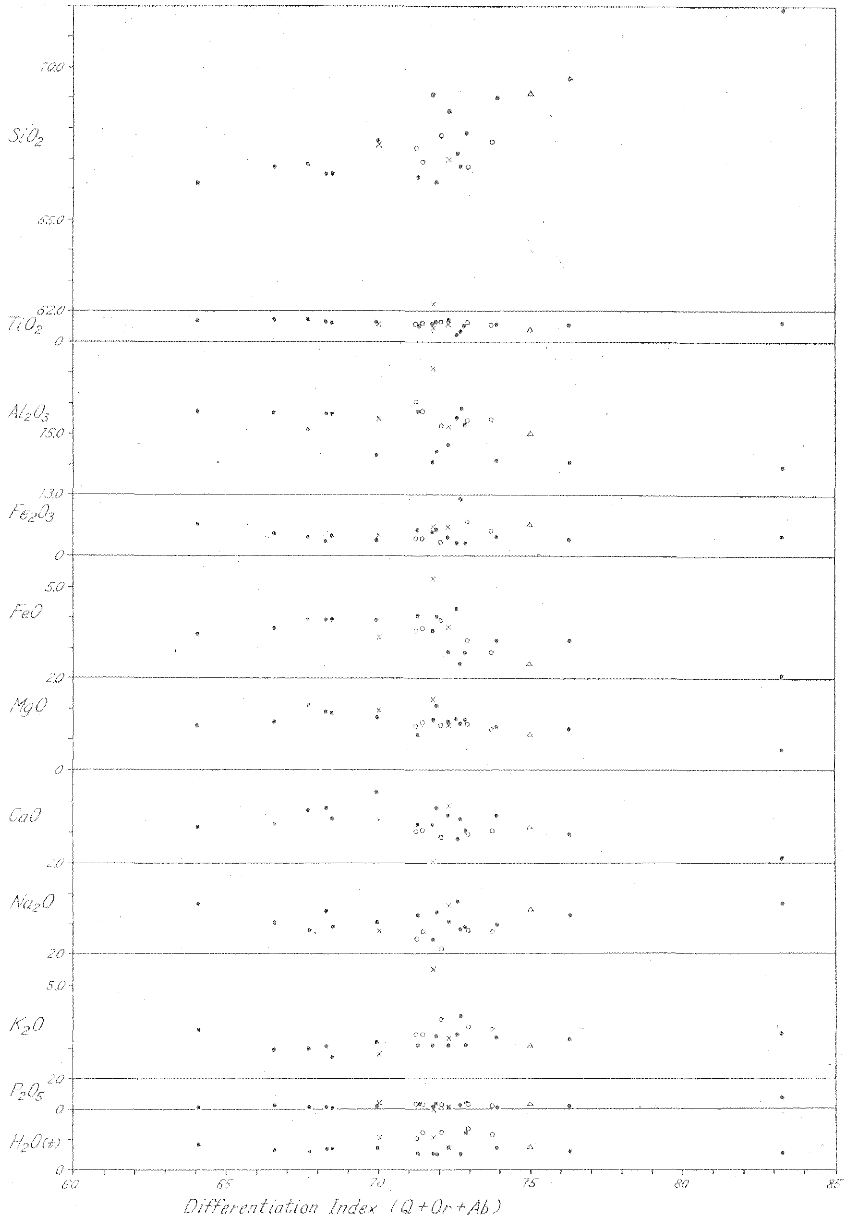

Fig. 3 Variation diagram of major components vs. Differentiation Index, on the Minami-ōsumi granite, including Uchinoura type.
(Ordinate...Oxides in weight percentage.
Abscissa...Differentiation Index (Normative Q+Or+Ab).
Key: Open circle ......Uchinoura type.
Solid circle ......Other Minami-ōsumi granite.
Cross ....the same as solid circle, employed to discriminate two points on the same Differentiation Index.
Triangle ....Average of granitic rocks in Japan (SiO_2 55%) after HATTORI et al. 1960.)

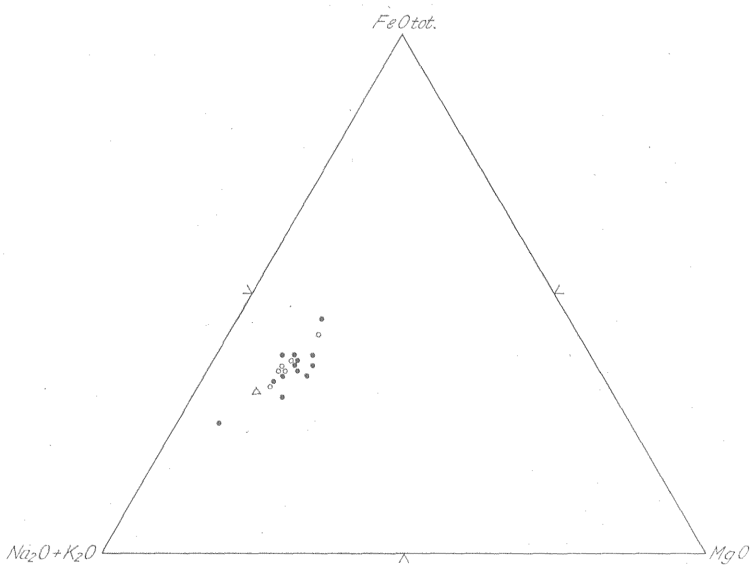

Fig. 4 Triangular diagram, FeO tot.: Na_2O+K_2O: MgO, on the Minami-ōsumi granite, including Uchinoura type.
(Key: the same as Fig. 3.
Following points are overlapped:)

FeO tot.	: Na_2O+K_2O	: MgO	
35	: 53	: 12	...three points.
32	: 56	: 12	...two points.
35	: 50	: 15	...two points.
33	: 55	: 12	...two points.

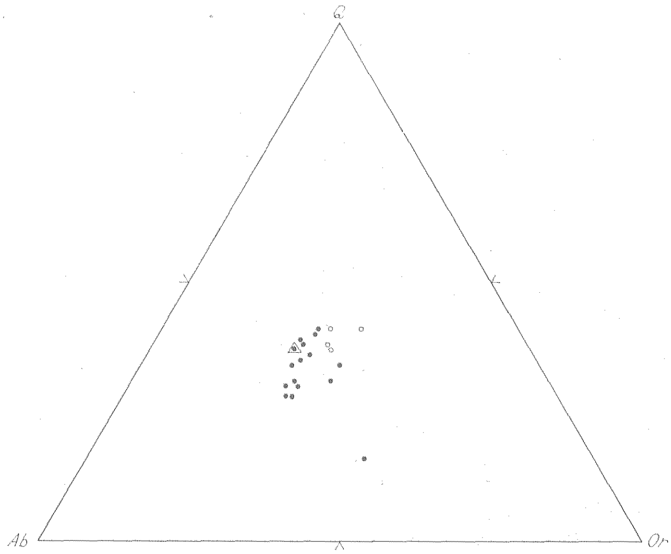

Fig. 5 Triangular diagram, Normative Q : Ab: Or, on the Minami-ōsumi granite, including Uchinoura type.
(Key: the same as Fig. 3.
Following points are overlapped:)

Q	: Ab	: Or	
38	: 37	: 25	...two points.
26	: 47	: 27	...two points.
25	: 49	: 26	...two points.
38	: 33	: 29	...two points.

Table 2 Chemical composition of the granodiorite and adamellite of Uchinoura type —Minor component, in ppm.

	(1)	(2)	(3)	(4)	(5)
Li	120	80	90	140	110
Rb	300	230	250	280	230
Sr	120	120	140	100	120
Ba	450	420	480	400	320
Ni	10	12	12	8	8
Co	10	12	10	12	8
Cr	18	25	18	28	20
V	70	120	90	110	70
Pb	35	35	25	30	25
Ga	78	23	20	25	23
B	—	12	—	8	—
Cu	30	40	35	30	25

(1)–(5) correspond to those in Table 1
Analyst: Kiyoshi TAKAHASHI

The Uchinoura type is distinctly unique in MgO–$H_2O(+)$ relation*. In Fig. 6, MgO–$H_2O(+)$ diagram, its points fall in a restricted area, in the vicinity of a point, MgO, 1.5%; $H_2O(+)$, 1.2%, apart from other Minami-ōsumi granite.

(b) Minor constituents

Minor constituents are analysed spectrochemically by DC arc method using JACO 3.4 stigmatic grating spectrograph (Table 2).

The minor constituents, just like the major constituents, fall in a narrow range of variation respectively (Fig. 7). They follow after their replaceable major constituents, so that ratios of the minor to major constituents converge in quite narrow range (Table 3). Such convergency may partly due to the simplicity of rock forming minerals; for instance, the mafic mineral is mostly biotite in which relations of minor constituents such as Li, Ni, Co, Cr, to their replaceable major constituents, Mg and Fe, are supposed to be constant.

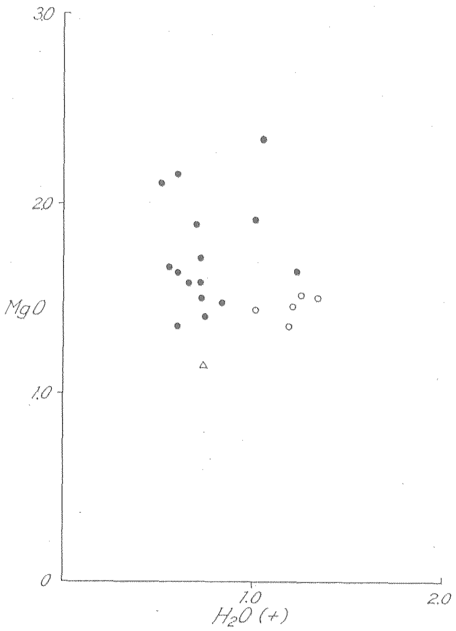

Fig. 6 Relation between MgO vs. $H_2O(+)$, in weight percentage, on the Minami-ōsumi granite.
(Key: the same as Fig. 3.
Following point is overlapped: MgO–1.89: H_2O–0.70....two points.)

* The meaning of MgO–$H_2O(+)$ relation will be soon discussed in a separate paper by one of the writers, T. NOZAWA.

Table 3 Ratios of minor to major constituents in the granodiorite and adamellite of Uchinoura type

Ratio	(1)	(2)	(3)	(4)	(5)
Li/Mg	13.3	8.6	10.5	16.1	13.6
Li/Mg+Fe	2.9	1.9	2.2	3.3	3.1
Rb/K	9.8	8.0	8.8	8.6	7.7
Sr/Ca	5.6	3.9	6.5	5.0	5.5
Ni/Mg	1.1	1.3	1.4	0.9	1.0
Ni/Mg+Fe	0.2	0.3	0.3	0.2	0.2
Co/Mg+Fe	0.2	0.3	0.2	0.3	0.2
Cr/Mg+Fe	0.4	0.6	0.4	0.7	0.6
Ga/Al	1.0	0.3	0.2	0.3	0.3
Pb/K	1.2	1.2	0.9	0.9	0.8

(1)–(5) correspond to those in Table 1, 2

In comparison with other granitic rocks in Japan (e.g. Okada, 1955), the granodiorite and adamellite of Uchinoura type, bear some characteristic features. Ba, Sr and B contents are relatively low. Especially, low content or vacancy of B is conspicuous and is seemingly peculiar, as tourmaline is abundant in the aplite characteristically. Probably, B might have concentrated into aplite from the granodiorite too exceedingly.

The relative abundance of Li may be due to abundance of biotite in the granodiorite, as Li is, by some instances, (e.g. Heier & Taylor, 1959), low in potassium feldspar, so that Li may mostly concentrate in biotite.

Roughly speaking, as for the minor constituents, the granodiorite and adamellite of Uchinoura type are similar to common andesite (SiO_2 60–65%), with a little higher contents of Ni, Co, Cr and V.

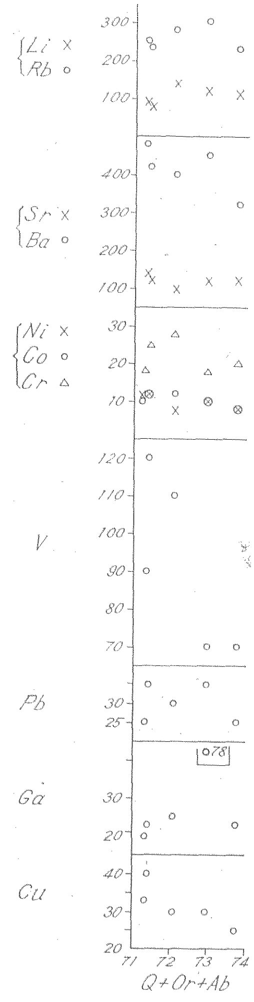

Fig. 7 Variation diagram of minor constituents vs. Differentiation Index, on the granodiorite and adamellite of Uchinoura type. (Ordinate: minor constituents in ppm. Abscissa: Differentiation Index. Key: the same as Fig. 3.)

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内之浦地域の南大隅花崗岩の岩石化学

川野 昌樹　高橋 清　野沢 保

要　旨

九州・大隅半島南部に分布する花崗岩類は，南大隅花崗岩として一括される。内之浦北部の花崗岩は，一連の類似性をもち，南大隅花崗岩類のなかでも，独自の成分分布をもつようである。ただし，九州の西南日本外帯花崗岩の一般的特性をもっていることにかわりはない。