報　　文

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Petrochemistry of Granitic Rocks in Hayatsukigawa Area, Hida Mountains

By

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Abstract

Seven samples from granitic rocks in the Hayatsukigawa area are analysed chemically about their major components. Petrochemically, as like as petrographically, they all belong to Funatsu granite which is composed of two types, Funatsu and Shimonomoto. Four of the analysed samples are of Funatsu type and the others are of Shimonomoto type respectively. Some diversities from average Funatsu granite are considered to be reffered mainly to mylonitization and microclinization.

Scope of the present paper

Along the Hayatsukigawa river there is exposed a peculiar granitic rock of aplitic appearrance more than 50 km^2 wide. Geologically it seems probable to

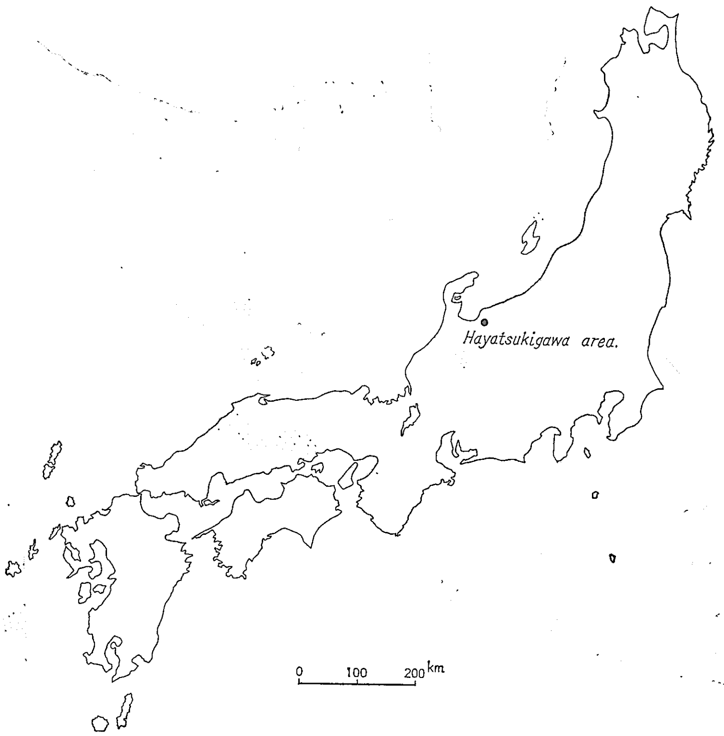

Fig. 1 Index to the Hayatsukigawa area.

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consider this aplitic granite as a member of Funatsu granite which is the most predominant granite in the Hida metamorphic belt. Its petrographic investigation is now being carried out by the present writers. In the present paper the writers intend to elucidate petrochemical character of the aplitic granite and its associated granitic rocks.

Geologic setting

In the Hida mountains, there are exposed metamorphic and granitic rocks of the Hida metamorphic belt (Fig. 2). Granitic rocks, named Funatsu granite, are divided into two types, Shimonomoto type and Funatsu type which are in most cases, exposed together in close relation. The rocks of the Funatsu type are granodioritic in petrographic character and are intruded into rocks of the Shimonomoto type which is mainly quartzdioritic or tonalitic. The Funatsu granite is intruded into Carboniferous sediments and is covered by basal conglomerate of Tetori formation, Jurassic. The Funatsu granite is about 180 m. y. old after isotopic age determination.

The Hayatsukigawa area is located near the northeastern end of the Hida metamorphic belt where gneisses, limestones and the Funatsu granitic rocks are widely developed.

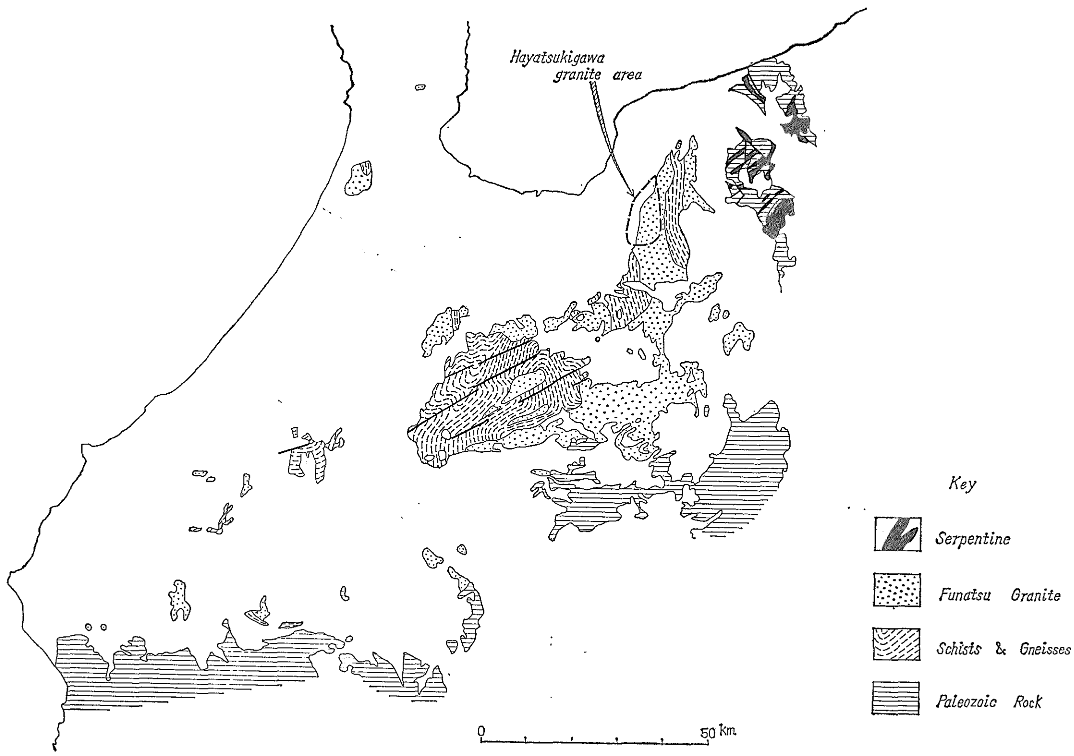


Fig. 2 Basement rock distribution in the Hida Mountains.

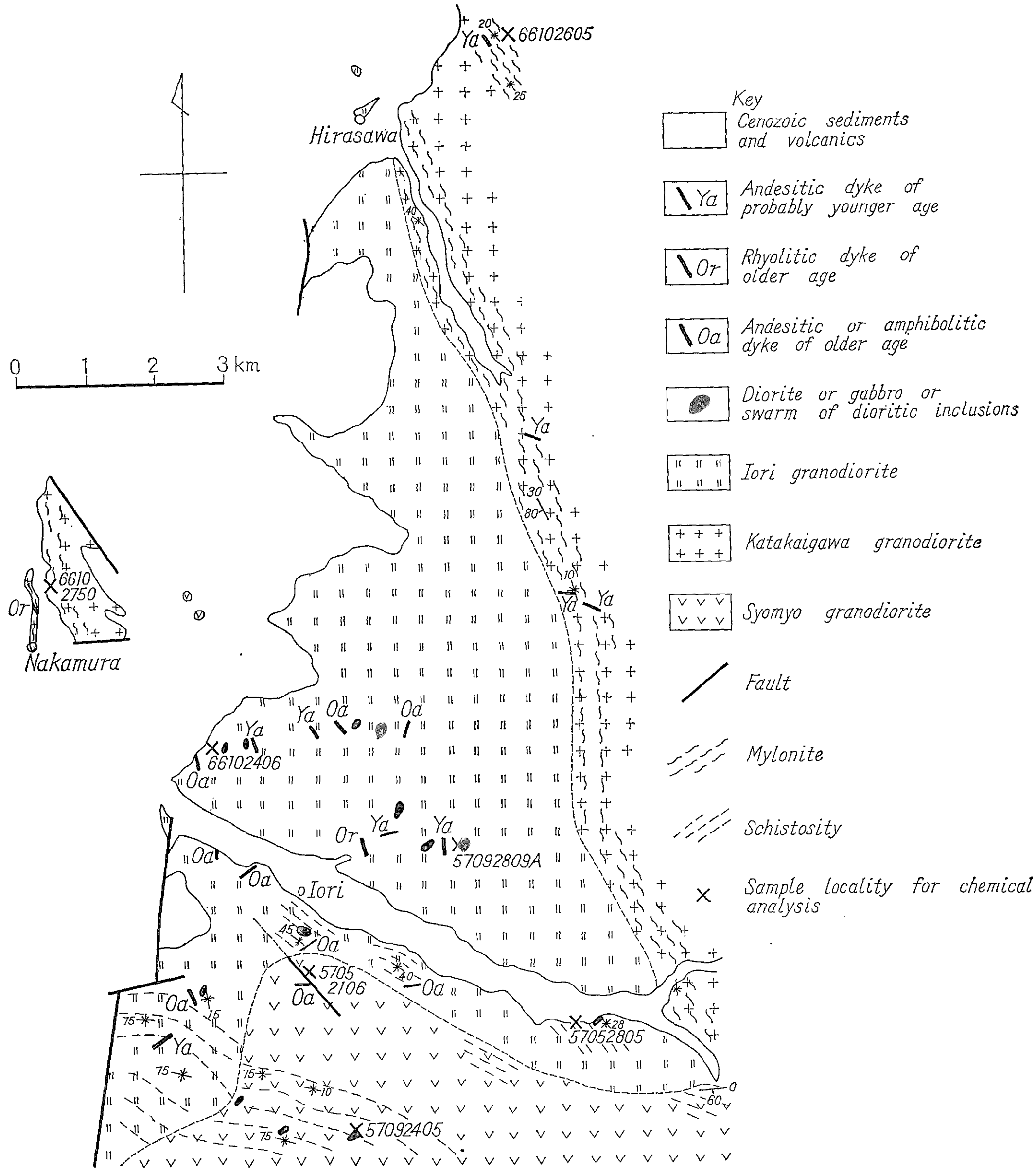


Fig. 3 Geologic Map of Hayatsukigawa area.

Granitic rocks in the Hayatsukigawa area

In the Hayatsukigawa area, there are three masses of granitic rocks (Fig. 3). They are Shomyo granodiorite of Shimonomoto type, Katakaigawa granodiorite of Funatsu type and Iori granodiorite (T. NOZAWA & T. SAKAMOTO, 1960). The Iori granodiorite is intruded into the Shomyo granodiorite and the Katakaigawa granodiorite, too. The direct relation of the Katakaigawa granodiorite and the Shomyo granodiorite is not clear but probably the latter is older, because, in other area, the Funatsu granodiorite is intruded into the Shimonomoto quartzdioritic rock.

Shomyo granodiorite, exposed in the southern part of this area, is coarse- or medium-grained, tonalite and granodiorite, of which main mafic mineral is commonly hornblende with or without biotite. Weak gneissosity is found partly, especially near lenses of dioritic inclusion. Inclusions of diorite, limestone and biotite gneiss are found ubiquitously. Along the contact to the Iori granodiorite, it suffers strong mylonitization and microcline impregnation. Microcline impregnation is widely developed not only in the mylonitic border but also inside of the granodiorite mass, in fashion of porphyroblast, network of quartz-microcline veinlet etc.

Katakaigawa granodiorite, exposed on both the east and west sides of the Iori granodiorite is pink-colored, mylonitic granodiorite. It is often flecked by "augen"-like microcline porphyroblast in pale green-colored crushed matrix. Pink-colored pegmatic veinlets are abundant and some of them are free from mylonitization. Diorite and schist are included as small rounded mass or lense inclusion.

The Iori granodiorite is fine-grained, reddish pink-colored granite, adamellite and granodiorite. It is relatively uniform and poor in inclusions. Only diorite inclusions are found rarely as small masses or swarms of fragments. Weak gneissosity develops partly, some part of which may due to mylonitization. Aplite, graphic granite and greisen are found as veins or lenses sporadically.

Description of analysed samples

(1) Fine-grained biotite granodiorite (Iori granodiorite) TN 57092809 A

Nabezo along Hayatsukigawa River, Kamiichi-cho, Nakaniikawa-gun, Toyama Pref.

It is fine-grained, reddish pink-colored and relatively uniform without parallel structure.

Under the microscope, it is mainly composed of biotite, plagioclase, quartz and microcline with small quantities of iron ore, apatite and sphene. Biotite is small in shape and also in quantity, 0.5-1.5 mm across, and is nearly entirely chloritized. Plagioclase, hypidiomorphic, 1-3 mm across, is commonly decomposed but has fresh rim of oligoclase. In the decomposed core, small muscovite flakes are often scattered. Quartz is granular, 1-2 mm across. Microcline, allotriomorphic, 1-3 mm across, relatively fresh, has cross-hatched structure. Sphene, idiomorphic, 0.5-1.0 mm across, often contains iron ore.

(2) Fine-grained biotite granodiorite (Iori granodiorite) TN 66102406

Kuwakobidani along Hayatsukigawa River, Kamiichi-cho, Nakaniikawa-gun, Toyama Pref.

It is of quite similar appearance as (1).

Under the microscope, it is mainly composed of biotite, microcline, quartz and plagioclase with small quantities of iron ore and apatite. Biotite, 0.5-1.0 mm across, is nearly entirely replaced by chlorite and prehnite. Microcline is large, 3-5 mm across, and includes other minerals porphyroblastically. Microcline is fresh and has cross-hatched structure. Quartz is granular, 1-3 mm across. Plagioclase is prismatic and nearly idiomorphic, 3-5 mm across, and is strongly decomposed with relatively fresh rim of oligoclase composition.

(3) Fine-grained biotite adamellite (Iori granodiorite) TN 57052805 B
Zoromeki along Hayatsukigawa River, Kamiichi-cho, Nakaniikawa-gun, Toyama Pref.

It is of quite similar appearance as (1), except schistosity in the direction of N 25 W, nearly parallel to the boundary of the Iori granodiorite and the Shomyo granodiorite.

Under the microscope, it is mainly composed of biotite, microcline, quartz and plagioclase with small quantities of iron ore, apatite and zircon. Biotite, 0.2-0.3 mm across, is decomposed strongly and is replaced by chlorite and some opaque minerals. Microcline, hypidiomorphic, 2-5 mm across, is relatively fresh and has cross-hatched structure. Quartz is granular, 2-3 mm across. Plagioclase, hypidiomorphic, 1-4 mm across is relatively small in quantity, and is strongly decomposed. Small flakes of muscovite are scattered in the core of plagioclase crystal.

(4) Hornblende granodiorite (Shomyo granodiorite) TN 57092405
Sanmaidaki of Sengokugawa River, Kamiichi-cho, Nakaniikawa-gun, Toyama Pref.

It is light-colored and coarse-grained without any parallel structure.

Under the microscope, it is mainly composed of hornblende, biotite, plagioclase, quartz and microcline with small quantities of iron ore, apatite and sphene. Hornblende, hypidiomorphicin prism, 1-3 mm, rarely up to 8 mm long, has often sieve structure. Pleochroism of hornblende is, X : brownish green, Y, Z : green. Biotite, 1-3 mm across, is accompanied by hornblende and is strongly decomposed and replaced by chlorite and epidote. Plagioclase, hypidiomorphic in prism, 3-5 mm long is decomposed to some extent and is nearly oligoclase in composition. In the interior of the plagioclase crystal, small patches of microcline is scattered. Microcline, commonly large porphyroblastic, 5-8 mm across, often makes graphic intergrowth with quartz. Quartz is granular, 2-4 mm across. Apatite and iron ore tend to crowd near hornblende crystals.

(5) Biotite tonalite (Shomyo granodiorite) TN 57092006
Akatani along Hayatsukigawa River, Kamiichi-cho, Nakaniikawa-gun, Toyama Pref.

It is relatively dark-colored, medium-grained and has no parallel structure.

Under the microscope, it is mainly composed of biotite, plagioclase, quartz and microcline with small quantities of iron ore, apatite and sphene. Biotite, 0.5-1.0 mm across, chloritized to some extent, has pleochroism, X : nearly colorless, Y, Z : brown. Plagioclase, hypidiomorphic in prism, 2-5 mm long, is strongly decomposed and contains small flakes of muscovite. Quartz is relatively small in quantity, granular, 0.5-1.0 mm across. Microcline is also small in quantity, allotriomorphic interstitially, and is fresh with cross-hatched structure. Iron ore is mainly magnetite with subordinate quantity of pyrite.

(6) Biotite muscovite granitic mylonite (Katagaigawa granodiorite) TN 66102605
Betsumatadani along Katakaigawa River, Kurobe-shi, Toyama Pref.

It is relatively dark-colored, medium-grained with parallel structure caused by mylonitization. Augen-like microcline porphyroblast and puddy matrix make mylonitic parallel structure together.

Under the microscope, porphyroblastic microcline, hypidiomorphic, of nearly round outline, 3-8 mm across, is conspicuous and includes other fine-grained minerals. Matrix is mainly composed of quartz, biotite, muscovite and plagioclase with small quantities of iron ore, apatite and zircon. Biotite forms films of fine-grained crystals and is to some extent chloritized with pleochroism, X : pale brown, Y, Z : deep brown with greenish tint. Muscovite is small in quantity and is always accompanied by biotite. Plagioclase, idiomorphic in prism, 1.0-1.5 mm long, is strongly decomposed and crushed on its border slightly. Quartz is most predominant in the matrix, and is fine-grained, 0.03-0.05 mm across, and plays dominant role in giving the rock puddy appearance.

(7) Biotite adamellite (Katakaigawa granodiorite) TN 66102705 B
Nakamura along Hayatsukigawa River, Kamiichi-cho, Nakaniikawa-gun, Toyama Pref.

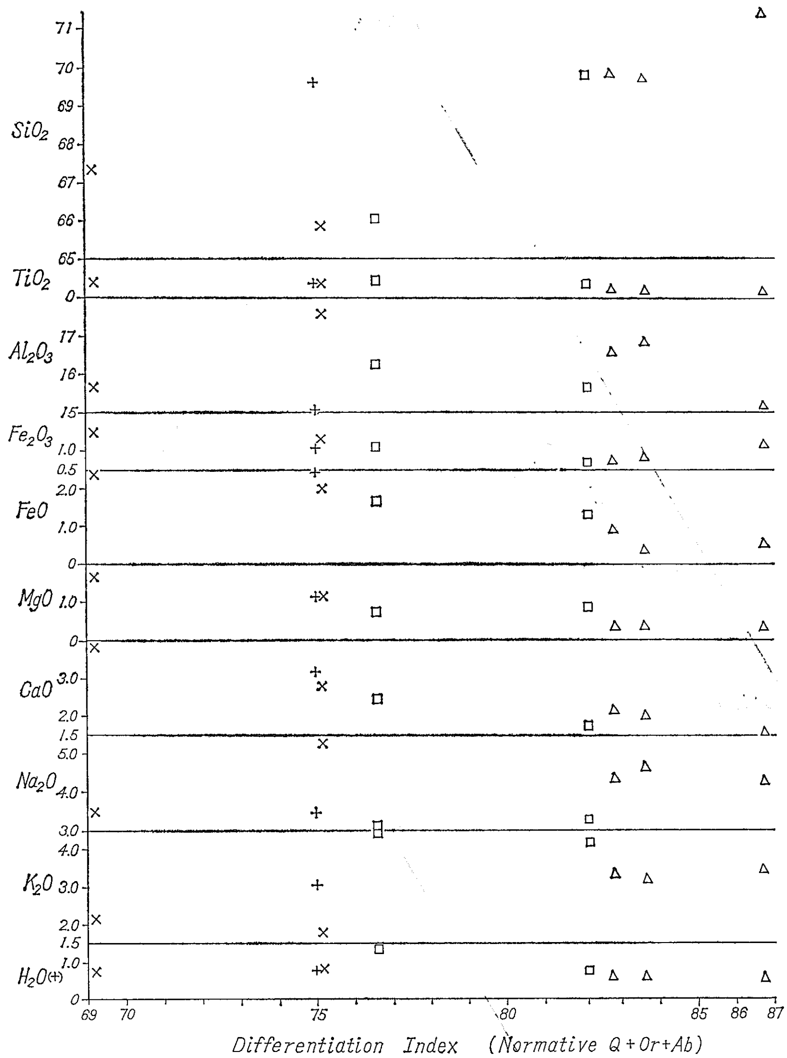
It is relatively dark-colored with pale greenish tint, medium-grained, and weakly schistose. It is mylonitized not so strongly, though this sample was taken from mylonite zone near the boundary to the Iori granodiorite.

Under the microscope, it is mainly composed of biotite, microcline, quartz and plagioclase with small quantities of muscovite, apatite, iron ore and sphene. Biotite, 2-4 mm across, is mostly chloritized and its survived part is of green-colored variety. Muscovite is small in shape as well as in quantity. Microcline, hypidiomorphic, 3-6 mm across, is relatively fresh and has beautiful cross-hatched structure. Quartz is irregular or granular in shape, 2-4 mm across. Plagioclase, hypidiomorphic granular, 2-4 mm across is strongly decomposed and small patches of microcline are scattered in the crystal.

Some comments on chemical composition of the Iori granodiorite and its associated rocks

(1) Shomyo granodiorite

Two samples were analysed. Their chemical compositions are of Shimonomoto type rightly, as is shown in Fig. 5-7. The diversity of some components, for instance, alkalies, may partly due to the impregnation of materials, probably in relation with the intrusion of Funatsu type granitic rocks. Such impregnation may be represented by microcline porphyroblast or minute flakes of microcline or



Key to Figs. 4–7.

- △ Iori granodiorite
- ◻ Katakaigawa granodiorite
- × Syomyo granodiorite
- ○ Funatsu granodioritic rocks (Funatsu granite)
- ● Shimonomoto quartzdioritic rocks (Funatsu granite)
- ⊕ Dioritic inclusions in Funatsu granite
- + Average of Japanese granitic rocks (After H. Hattori et al. 1960)
- Boundary between rocks of Funatsu type and Shimonomoto type

Fig. 4 Variation diagram of major components vs. Differentiation Index, on Hayatsukigawa granitic rocks. (ordinate : oxides in weight percentage, abscissa : Differentiation Index)

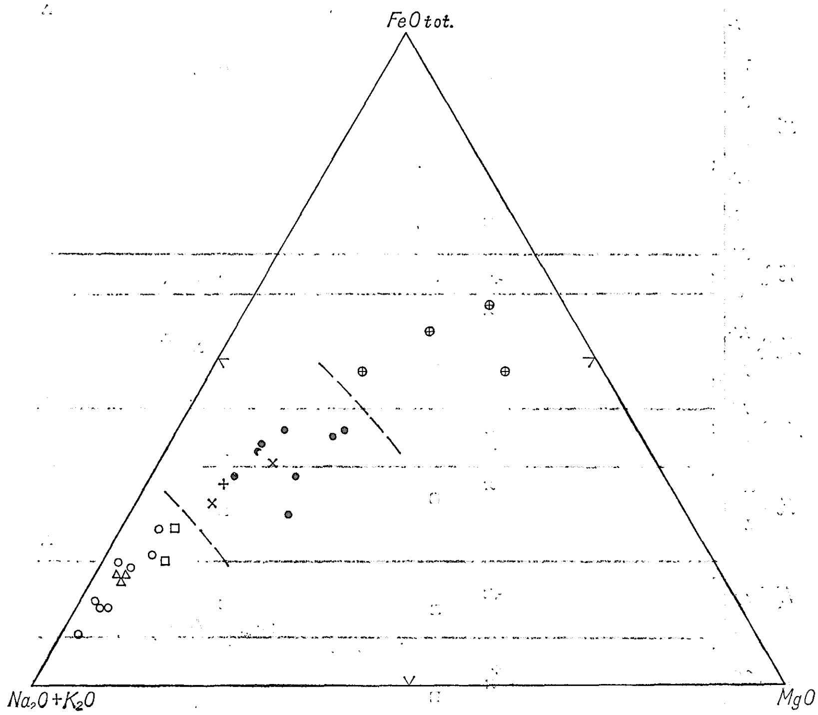


Fig. 5 Triangular diagram, FeO tot. : Na_2O+K_2O : MgO on Hayatsukigawa granitic rocks and Funatsu granites.

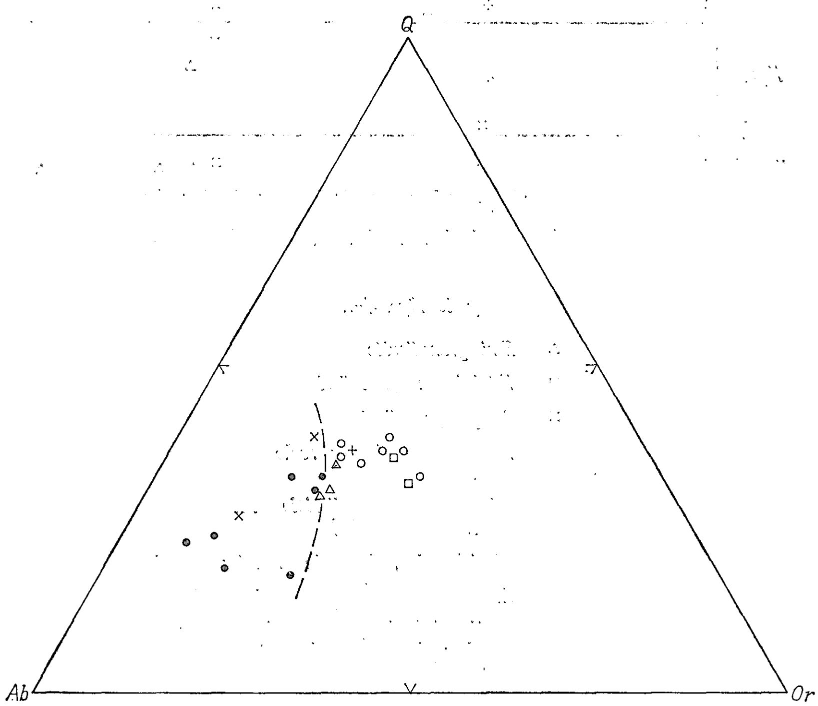


Fig. 6 Triangular diagram, normative Q : Ab : Or on Hayatsukigawa granitic rocks and Funatsu granites.

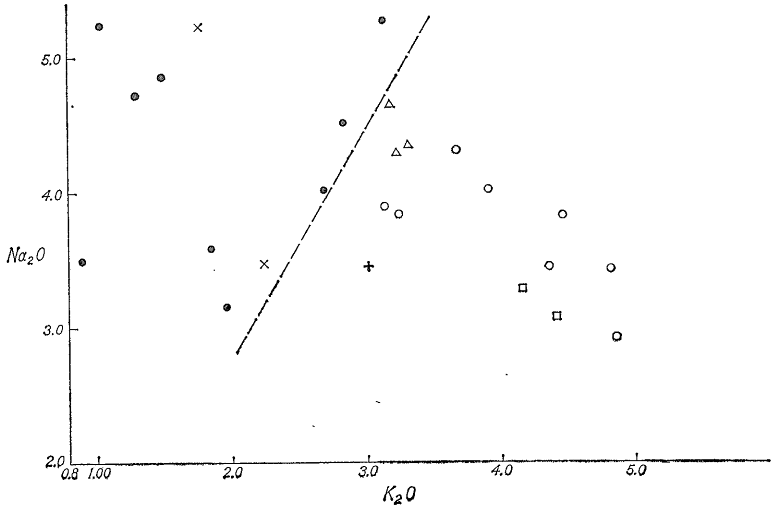


Fig. 7 Na_2O-K_2O relation on Hayatsukigawa granitic rocks and Funatsu granites. (in weight percentage)

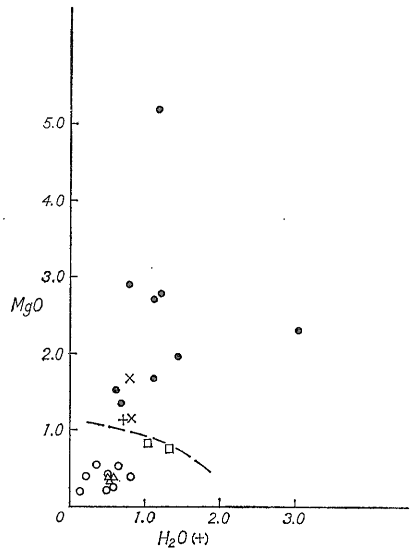


Fig. 8 MgO-$H_2O(+)$ relation on Hayatsukigawa granitic rocks and Funatsu granites. (in weight percentage)

muscovite in plagioclase crystals (Fig. 7).

(2) Katakaigawa granodiorite

Two samples from each side of the Iori granodiorite are analysed. They are quite similar to each other in chemical composition as well as in petrographic character. Their chemical compositions are rightly of the Funatsu type, as is shown in Fig. 5-7. Among rocks of the Funatsu type, they are relatively rich in K_2O, probably due to abundance of microcline which might have been introduced during mylonitization. Also its relative high content of H_2O and MgO may

Table. Chemical Composition of granitic rocks in Hayatsukigawa area, Hida Mountains

	1	2	3	4	5	6	7	A-1	A-2	A-3	B-1	B-2	C
SiO_2	69.86	69.74	71.96	67.34	65.88	66.04	69.82	70.52	66.61	67.93	71.52	62.15	69.17
TiO_2	0.19	0.18	0.17	0.43	0.39	0.46	0.33	0.18	0.41	0.40	0.22	0.57	0.39
Al_2O_3	16.59	16.89	15.17	15.67	17.57	16.29	15.67	16.21	16.62	15.98	15.03	17.21	15.00
Fe_2O_3	0.75	0.83	1.19	1.49	1.31	1.10	0.68	0.92	1.40	0.89	0.89	2.46	1.05
FeO	0.90	0.88	0.56	2.40	2.00	1.67	1.34	0.78	2.20	1.51	0.96	2.76	2.48
MnO	0.04	0.05	0.03	0.09	0.12	0.06	0.08	0.04	0.11	0.07	0.05	0.11	0.10
MgO	0.35	0.31	0.36	1.68	1.14	0.76	0.83	0.34	1.41	0.80	0.48	2.04	1.15
CaO	2.10	2.00	1.51	3.85	2.74	2.45	1.57	1.87	3.30	2.01	1.93	4.48	3.15
Na_2O	4.35	4.65	4.28	3.47	5.23	3.07	3.28	4.42	4.35	3.18	3.74	4.30	3.45
K_2O	3.32	3.18	3.43	2.14	1.77	4.41	4.16	3.31	1.96	4.29	3.87	1.92	3.01
P_2O_5	0.05	0.03	0.04	0.11	0.13	0.14	0.10	0.04	0.12	0.12	0.08	0.35	0.13
$H_2O(+)$	0.58	0.55	0.55	0.73	0.81	1.31	1.03	0.56	0.77	1.17	0.59	1.31	0.74
$H_2O(-)$	0.18	0.12	0.16	0.16	0.20	0.20	0.30	0.15	0.18	0.25	0.13	0.23	0.30
Fe	0	0	0	0	0	0.09	0.14						
SO_3	0	0	0	0	0	0.01	0.01						
S	0	0	0	<0.01	<0.01	0.05	0.08						
CO_3	0.39	0.23	0.10	0.12	0.26	1.53	0.15	0.24		0.84			
Total	99.65	99.64	99.51	9.68	99.55	99.64	99.57						100.12
	(Norm)												
Q	25.85	25.51	30.31	27.28	20.41	24.61	29.76	27.22	23.85	27.19	29.87	16.69	27.97
C	2.04	2.23	1.79	0.88	2.35	2.36	3.15	2.02	1.64	2.71	1.54	0.69	0.64
Or	19.59	18.81	20.26	12.53	10.46	26.04	24.60	19.55	11.50	25.32	22.83	11.40	17.81
Ab	37.33	39.32	36.18	29.36	44.30	25.96	27.77	37.61	36.83	26.87	31.74	36.38	29.20
An	10.04	9.74	7.20	18.48	12.81	11.25	7.18	9.00	15.65	9.22	8.84	20.58	14.77
Sal. tot.	94.85	95.61	95.74	88.53	90.33	90.22	92.46						90.39
En	0.87	0.77	0.89	4.19	2.84	1.90	2.07	0.84	3.52	1.99	1.19	5.08	2.86
Fs	0.79	0.73		2.51	2.16	1.52	1.50	0.76	2.34	1.51	0.93	2.30	3.22
Mt	1.09	1.20	1.32	2.15	1.89	1.60	0.99	1.20	2.02	1.30	1.23	3.60	1.53
Hm			0.29										
Il	0.36	0.33	0.32	0.82	0.74	0.88	0.61	0.34	0.78	0.75	0.41	1.08	0.74
Ap	0.14	0.07	0.10	0.23	0.30	0.34	0.23	0.12	0.27	0.29	0.26	0.52	0.30
Fem. tot.	3.25	3.10	2.92	9.90	7.93	6.24	5.40						
Total	98.10	98.71	98.66	98.43	98.26	99.46	97.86						99.04
Na_2O/K_2O	1.31	1.46	1.24	1.62	2.95	0.69	0.78	1.34	2.22	0.74	1.00	2.62	1.15
MgO/FeO	0.22	0.19	0.43	0.45	0.36	0.28	0.43	0.28	0.41	0.35	0.25	0.41	0.46
Q+Ab+Or	82.77	83.64	86.75	69.17	75.17	76.61	82.13	75.77	72.18	79.38	84.44	64.48	74.98

Sample No.
1 : TN 57090809 A Fine-grained biotite granodiorite (Iori granodiorite), Nabezo along Hayatsukigawa River, Kamiichi-cho.
2 : TN 66102406 Fine-grained biotite granodiorite (Iori granodiorite), Kuwakobidani along Hayatsukigawa River, Kamiichi-cho.
3 : TN 57052805 B Fine-grained biotite adamellite (Iori granodiorite), Zoromeki along Hayatsukigawa River, Kamiichi-cho.
4 : TN 57092405 Hornblende granodiorite (Shomyo granodiorite), Sanmaidaki of Sengokugawa River, Kamiichi-cho.
5 : TN 57092006 Biotite tonalite, (Shomyo granodiorite), Akatani along Hayatsukigawa River, Kamiichi-cho.
6 : TN 66102605 Biotite muscovite granitic mylonite, (Kattakaigawa granodiorite), Betsumatadani along Katakaigawa River Uozu-shi.
7 : TN 66102705 B Biotite adamillite, (Katakaigawa granodiorite), Nakamura along Hayatsukigawa River, Kamiichi-cho.
A-1 : Average 1~3 (Iori granodiorite).
A-2 : Average 4~5 (Shomyo granodiorite).
A-3 : Average of 6~7 (Katakaigawa granodiorite).
B-1 : Average of 8 Funatsu granodioritic rocks
B-2 : Average of 9 Shimonomoto quartzdioritic rocks
C : Average of granitic rocks in Japan (SiO_2>55%) after H. Hattori et al. 1960.

correspond to abundance of chloritic minerals produced by the mylonitization.

(3) Iori granodiorite

Three samples were analysed. They are quite similar in chemical composition to each other. Their chemical compositions are rightly of the Funatsu type, as is shown in Fig. 5-7. Among rocks of the Funatsu type, they are peculiar in high content of Na_2O. They are aplitic, not only in appearance but also in chemical composition as is shown in high Differentiation Index or in normative salic mineral total, nearly 95 %. However, several points are peculiar to common aplite, that is, poorness in quantity of microcline, relative abundance of plagioclase, frequent occurrence of sphene, etc.

(4) Na_2O-K_2O relation of Funatsu granite

The Funatsu type rocks seem to have tendency to make negative relation between Na_2O and K_2O contents (Fig. 7). On the other hand, the Shimonomoto type rocks does not have any regularity in the same relation. The irregularity of the relation in the Shimonomoto type rock may partly due to the heterogeneous impregnation of K_2O at the time of intrusion of the Funatsu type rocks.

Comprehensive study of the Funatsu granite will be soon published in a separate paper by one of the writers.

Literature

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ひだ山地，早月川地域の花崗岩類の岩石化学

川 野 昌 樹・野 沢 保

要 旨

早津川地域の７コの花崗岩について，主成分の化学分析をした。岩石学的性質と同様に化学的性質でも，船津型花崗岩に属する。船津花崗岩は船津型と下三本型の２型を含むが，分析された花崗岩のうち，４コは船津型に，３コは下三本型に属する。各分析植のうちで，船津花崗岩のそれぞれの平均からはずれるものがあるのは，おもにミロナイト化作用と微斜長石化作用によると考えられる。