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PETROGRAPHIC NOTES ON THE ROCKS OF NAKANOSIMA, TOKARA-ISLANDS, SOUTHWESTERN JAPAN.

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Introduction

Nakano-sima is one of Tokara-islands, which is located between 30 N Lat. to 29 N Lat. and about 130 Long. in the southwest of Kyushu.

Tokara-islands include ten islands, Kuchinos-ima, Nakanos-ima, Suwanose-zima, Taira-zima, Akuseki-zima, Gaja-zima, Ko-zima, Kogaja-zima, Kodakara-zima and Takara-zima, all belonging to the Ryukyu volcanic zone.

In these islands, Nakno-sima and Suwanose-zima are noted for their active volcanoes, the former is rest now and the latter is exploding up bombs and ashes cloulds frequently.

The Scientific Expedition of Osaka Museum of Natural History was sent to Tokara-islands from May 25th to June 13th in 1953. The writer, as one of the geological members of this Expedition, visited especially Nakano-sima and Suwanose-zima and collected some specimens of volcanic rocks.

Petrographic study on the rocks of Suwanose-zima already reported by H. MATSUMOTO, a member of this Expedition. In this paper, the writer intends to describe on the rocks of Nakano-sima.

In publishing this paper, the writer wishes to express his sincere thanks to Mr. Y. TSUTSUI, Director of Osaka Museum of Natural History, and the other members of the Expedition for their kind helps in the field works. He owes also to Mr. M. TSURUMAKI of Geoscience Division of Osaka City Univ. for his obliging works in the chemical analysis of the rocks.

Outline of the Geography and Geology

Nakano-sima is the largest island in Tokara-islands; it is about 30.5 square kilometers. Topographic map of the island is shown in Fig. 1, a.

Topographically, this island is divided into two areas—the northern area and the southern area—by the Nigoriura-Nanatuyamaura line.

The northern area has the youngest volcano-Mt. Ontake (980m), forming the

* Contribution from the Osaka Museum of Natural History, no. 44
Contribution from the Division of Geoscience, Inst. Polytechinics, Osaka City Univ., no. 92

beautiful conide. Mt. Ontake is a rest volcano with a crater, but three solfataras are observed in the bottom of the crater.

On the other hand, the southern area is occupied by the dissected lava plateau. The average height of the plateau is about 300m above sea level. A narrow plain (about 200m above sea level) connects the northern conide with the southern plateau.

Such a geographic features is also significant geologically. (Fig. 1. b.) The northern area is occupied by the youngest volcanics, named Ontake cone. The rock of the Ontake volcanics is dark greyish two-pyroxene-andesite.

The southern area consists of the Siizaki volcanics and the Ooyama volcanics. The Siizaki volcanics, occupying most part of the southern lava plateau, consists of lavas agglomerates and tuff breccias. The rock of the Siizaki volcanics is similar to that of the Ontake volcanics—dark greyish two-pyroxene-andesite. The Ooyama volcanics, occupying the southeastern corner of this island, occurs as a lava flow. The rock of the Ooyama is porphyritic tow-pyroxene-dacite with feldspar phenocrysts scattered in bluish-grey matrix.

Since the geological survey in Nakano-sima island could be made only for a week, the relationships of each volcanics colud not be satisfactorily clarified. However, judging from the geographical data, the writer assumes that the succession of volcanic activities is as follows (in order time):

A.	Ooyama volcanics	(Two-pyroxene-andesite)
B.	Siizaki volcanics	(Two-pyroxene-andesite)
C.	Ontake volcanics	(Two-pyroxene-dacite)

The above mentioned volcanics have pyroxene phenocrysts, but some agglomerates from the Nigoriura have hornblende phenocrysts. The rocks of the Nigoriura agglomerate are light-coloured hornblende-dacite, the post of which is not yet assigned.

The geological age of these rocks is not clear, but the writer supposes from the history of Cenozoic volcanism in Southwestern Japan, that Nakano-sima island was born at the Late Pliocene and volcanic activities continued from its birth up to the Recent.

The basement rocks are covered by these volcanics, and not exposed. No datum of the basement rocks in this island has been reported. However, in a neighbouring island, Taira-zima, the lava with xenolith of cordierite-hornfels was discovered by Suzuki (1936) and then in another neighbouring island, Suwanose-zima, the geological party of this Expedition collected the fragments of granite from the Odake lava. Judging from these facts, the writer supposes that the basement rocks of this island are granite and argillaceous rocks, the age of which are not yet known.

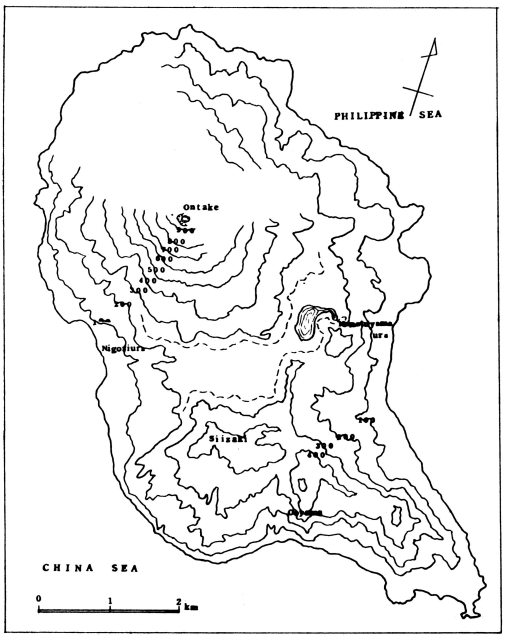

Fig. 1, a. Topographical Map of Nakano-sima.

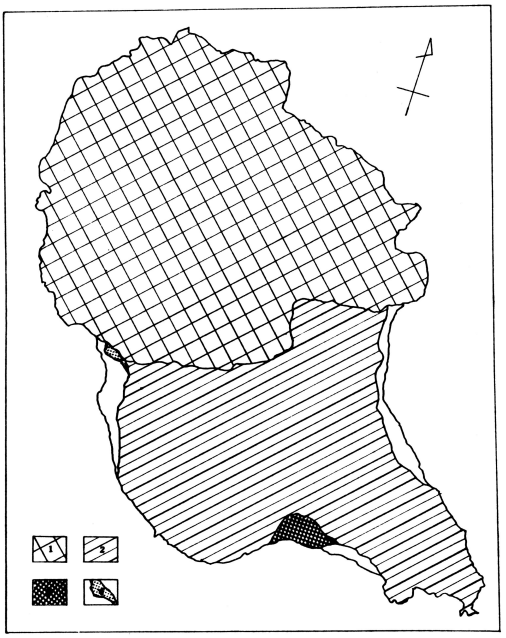

Fig. 1, b. Geological Map of Nakano-sima.
1: Ontake volcanics 2: Siizaki volcanics 3: Ooyama volcanics 4: Nigoriura agglomerate

Microscopic data on the volcanic rocks

A. Ooyama volcanics (Plate 8, A.)

The Ooyama volanics occur as lava flow about 200m or more in thickness. Mt. Ooyama, occupying the southeastern corner of this island, is type locality of the rocks. The rock is porphyritic two-pyroxene-andesite.

1) Rock forming minerals

The essential minerals of the rock are plagioclase, augite and hypersthene. These minerals occur as phenocryst or as microphenocryst.

Groundmass consists of these minerals togather with magnetite and glass.

2) Plagioclase

Plagioclase is of idimorphic or hypidomorphic forms, contains largest in phenocrysts, the maximum size is 8 mm or more in length.

Zonal structure and twinning are common, its composition rang as from An 46 to An 55%.

3) Augite

Augite is of short prismatic crystal habit. It has slightly pleochroism and shows hour-glass structure, its average size is about 1 mm. Index of augite phenocryst is shown in Table 1.

4) Hypersthene

Hypersthene occures as microphenocryst and rarely as phenocryst with idimorphic prismatic habit, its size is about 0.3 mm., the maximum is 2 mm in length. Optic properties of hypersthene are shown in Table 1.

Table 1. Optic properties of phenocrysts in two-pyroxene-dacite of Ooyama lava

Plagioclase	An 46–55%		
Augite	β 1.689–1.697		
Hypersthene	α 1.690–1.696 γ 1.700–1.704	$-2V=56°$	X′ pale pinkish Z′ pale bluish

5) Groundmass

Under the microscope, the groundmass is very fine and glassy, its constituent minerals are plagioclase, magnetite and glass, and pyroxene are rarely found.

B. Siizaki volcanics (Plate 8, B.)

The southern area of this island is mostly occupied by the Siizaki volcanics, which consists of alternations of two-pyroxene-andesite lava, agglomerate and tuff breccia.

C. Ontake volcanics (Plate 8, C.)

The active volcano, Ontake, is situted in the northern area of this island. Mt. Ontake is a beautiful strato-volcano, which consists of two-pyroxene-andesite, similar to that of the Siizaki volcanics.

Above mentioned two volcanics are much alike in character, thouth age of the volcanic activities is different from each other.

The microscopic descriptions are made collectively in the following:

1) Rock forming minerals

Phenocrysts are plagioclase, augite and hypersthene. Groundmass are composed of these mineral together with magnetite and glass. Under the microscope, the mineral assemblage is thought to be the Vd type after Kuno's classification.

2) Plagioclase

Plagioclase is of rectangular grains, its average size being 3 mm in length. Phenocysts of plagiclase show idiomorphic prisms and are usually 2 mm to 1 mm in length, but are sometimes 3 mm or more. Zonal structure is very pronounced, usually the marginal zone is more sodic than the continuous inner zone. It ranges from An 55 to An 68%. Twinning on Carlsbad and Albite laws is common.

3) Augite

Augite is preminating in the phenocrysts of these rocks. Phenocrysts of augite are found as short prismatic grains, sometimes showing twinning on (001) and rarely zonal structure. These sizes are 0.2×0.1 mm — 2.4×1.0 mm. Refractive indices are

shown in Table 2.

4) Hypersthene

Hypersthene occurs as phenocrysts and groundmass constituents in prismatic or needle forms, usually less than 1 mm in length. It has pale colour and slightly pleochroic. Optical properties of hypersthene are shown in Table 2.

Table 2. Optic properties of phenocrysts in two-pyroxene-andesite of Siizaki volcanics and Ontake volcanics

Plagioclase	An 55–68%		
Augite	α 1.691–1.693		
	β 1.696–1.699		
	γ 1.713–1.717		
Hypersthene	α 1.696–1.698		
	β 1.697–1.704	$-2V = 60°–62°$	X′ pinkish
	γ 1.705–1.709		Z′ pale greenish

5) Groundmass

Groundmass shows hyalopilitic texture, the constituent minerals are plagioclase, augite, hypersthene, magnetite and glass. In addition to them, tridymite and cristbalite are rarely found as druce minerals.

D. Nigoriura agglomerate (Plate 8. D.)

Nigoriura is a haven of this island. The sea-cliff consists of hornblende dacite agglomerate. The relations between the Nigoriura agglomerate and the other volcanics are not clear. But the writer thinks, that the age of activity of this agglomerate is earlier than the eruptions of the Siizaki volcanics, though some tuff breccia of the Siizaki volcanics has rarely hornblende dacite blocks.

The rock is divided in to two varieties i.e. greyish white and reddish types.

1) Rock forming minerals

The rock is porphyritic, with abundant feldspar, prismatic hornblende and subordinate quartz in fine groundmass. Under the microscope, microphenocrysts and groundmass are made up of these minerals together with hypersthene, magnetite, silica minerals and glass.

2) Plagioclase

The crystal habit of plagioclase are usually prismatic phenocrysts of plagioclase is about 0.6—1.6 mm in length, the variation of composition ranging from An 38 to An 40%.

3) Hornblende

Hornblende occurs as idimorphic long prismatic forms, varying from 0.2 to 1.2

mm in length. Under the microscope, hornblende are divided in to two varieties i.e. green and brown types, the green hornblende occurs in greyish white coloured rocks, and the brown hornblende occurs in reddish rocks. Brown hornblende is usually suffered from oxidation. Opitical properties of hornblende are shown in Table 3.

4) Quartz

Quartz is found as phencrysts, microphenocrysts and groundmass constituents. It has so-called corroded form, varying in size from 1 mm to 0.2 mm (microphenocrysts) and smaller (groundmass). The refractive index is about 1.543.

5) Hyperrthene

Hypersthene occurs as microphenocrysts and groundmass minerals, its maximum size is about 0.5 mm in length. Opitical properties of hypersthene are shown in Table 3.

Table 3. Optic properties of phenocrysts in hornblende-dacite of Nigoriura agglomerate

Plagioclase		An	38–42%	
Quartz		ω	1.543	
Hornblende	Green	α	1.654–1.658	X′ yellowish green
		β	1.660–1.668	Z′ brownish green
	Brown	β	1.708–1.713	X′ yellowish brown
				Z′ reddish brown
Hypersthene		γ	1.699–1.703	X′ pale pinkish
				Z′ pale blueish

6) Groundmass

It has porphyritic texture, with the above-stated minerals together with magnetite, silica minerals and glass.

Silica minerals are tridymite and cristobalite, which are found rarely as well-developed crystals. Their indices are lower than 1.500.

Chemical compositions of volcanic rocks

The results of chemical analyses of the typical specimens are given in Table 4 with their Norm.

These results show that the two types, the Ontake lava and the Siizaki lava are very much similar both megascopically and microscopically, while the Ooyama lava has same chemical character as the Nigoriura agglomerate.

The results of chemical analyses of the Ontake and the Siizaki lavas show the

Table 4. Chemical composition, Norm of Nakano-sima rocks

	1	2	3	4
SiO_2	58.89	58.47	65.03	65.18
Al_2O_3	18.07	18.27	16.81	16.73
Fe_2O_3	2.37	1.89	3.67	2.39
FeO	4.24	4.43	1.03	1.92
MgO	3.66	3.44	0.98	2.05
CaO	7.23	7.19	3.44	4.95
Na_2O	3.75	3.66	4.53	3.45
K_2O	0.99	0.89	1.56	1.16
TiO_2	0.76	0.82	0.80	0.59
MnO	0.07	0.08	0.07	0.08
$H_2O(+)$	0.28	0.78	1.17	0.96
$H_2O(-)$	0.08	0.27	0.86	0.27
Total	100.39	100.19	99.95	99.73
Q	10.8	11.3	23.0	25.6
Or	6.8	5.3	9.4	7.1
Ab	34.6	33.1	41.7	31.6
An	27.5	31.1	17.4	25.0
Wo	2.6	2.0	—	—
C	—	—	1.7	0.9
En	10.2	9.6	2.8	5.8
Fs	3.8	4.5	—	0.6
Il	1.1	1.1	1.1	0.8
Mt	2.6	2.0	0.7	2.6
He	—	—	2.2	—

1 Ontake lava (Two-pyroxene-andesite), analyzed by M. TSURUMAKI
2 Siizaki lava (Two-pyroxene-andesite), 〃 〃
3 Ooyama lava (Two-pyroxene-dacite), 〃 〃
4 Nigoriura agglomerate (Hornblende-dacite), 〃 〃

similar character with the lavas in the Suwanose-zima (MATSUMOTO, 1956), all belonging to the Ryukyu volcanic zone. The Ontake and the Siizaki lavas are characterized by richness in Fe_2O_3 and K_2O. The other compositions are contained in nearly the same degree as in Japanese effusive rocks (average of 57 andesite in Japan, YAMADA 1931).

On the contrary, the chemical compositions of the Ooyama lava and the Nigoriura agglomerate resemble closely that of Daly's average composition of dacite. The so called "Hai-isi" (Ash stone), forming the great calderas in the south Kyushu (MATSUMOTO, 1943), consists of several beds; tuff breccia, welded tuff and lava. "Hai-isi" belongs to andesite, tranchyandesite and dacite. Dacite in this island may be correspond to some dacite of "Hai-isi".

Normative Wo exists in the Ontake and the Siizaki lavas, but it is absent in the Ooyama lava and the Nigoriura agglomerate, and normative C is absent in former, but is present in latter.

Composition of normative feldspar, F-A-M and A-C-N diagram of the rocks are shown in Fig. 2.

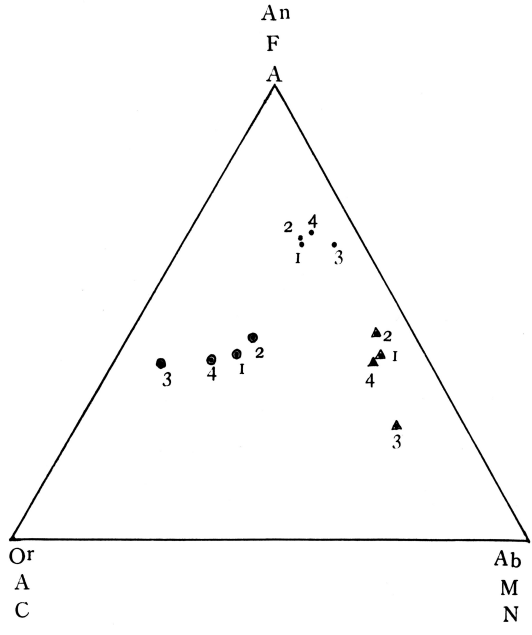

Fig. 2. An–Or–Ab ratio (△), F(Fe_2O_3+FeO) –A (Na_2O+K_2O) –M (MgO) ratio (◉) and A(Al)–C(Ca)–N(Na) atomic ratio (•) with the rocks of Nakano-sima.
1. Ontake vols. 2. Siizaki vols. 3. Ooyama vols. 4. Nigoriura agglo.

Conclusion

From the above data, rocks of the Nakano-sima is divided in two types from the petrolographical and petrochemical point of view.

The Ontake and the Siizaki volcanics have the same character as that of the Suwanose-zima and the further as the rocks in Mt. Sakura-zima volcano, Mt. Kirisima volcano, etc., all belonging to the Ryukyu volcanic zone. They are the most famous volcanoes in the southwest Japan, and these rocks are characterized by two-pyroxene-andesite and build up beautiful stratovolcano from the Latest Pleistocene to the Recent. In chemical composition, FeO, CaO, Na_2O contents are richer than the average of andesite in Japan, while Fe_2O_3 is poor (TANEDA, 1951).

The other hand, the rocks of the Ooyama and the Nigoriura volcanics are peculiar type, as compared with those of the Ryuku volcanic proper. There are dacite, while

the rocks of the Ryuku volcanics proper are said always to be two-pyroxen-andesite (KOZU and WATANABE, 1929). These rocks may be correspond to some member of "Hai-isi", which occur also in the Ryukyu volconic zone and formed the great calderas (Aso, Aira, Ata and Kikai calderas) at the Pleistocene.

The petrogenetic meaning may be very interesting, but the writer cannot discuss that problem, as the investigation is not throughing enough.

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Explanation of Plate 8
Photomicrograph of the Volcanic rocks from Nakano-sima

A. Ooyama lava

Two-Pyroxene-Dasite

×Ca. 30 // nicol

p: plagioclase

a: augite

h: hypersthene

B. Siizaki lava

Two-Pyroxene-Andesite

×Ca. 30 // nicol

p: plagioclase

a: augite

h: hypersthene

C. Ontake lava

Two-Pyroxene-Andesite

×Ca. 30 // nicol

p: plagioclase

a: augite

h: hypersthene

D. Nigoriura agglomerate

Hornblende-Dacite

×Ca. 30 // nicol

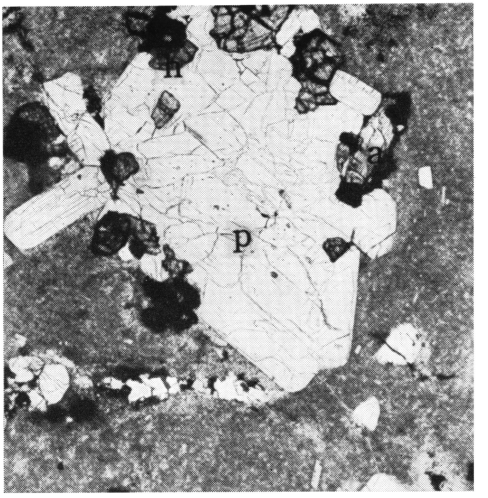
p: plagioclase

q: quartz

ho: hornblende

h: hypersthene

A.



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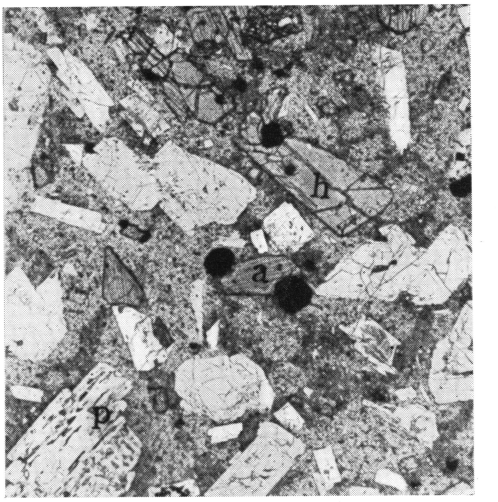

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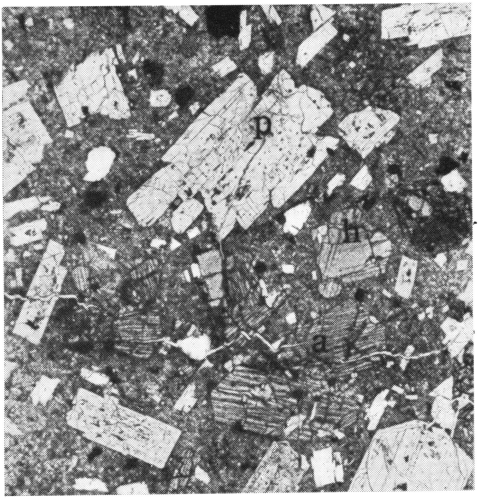
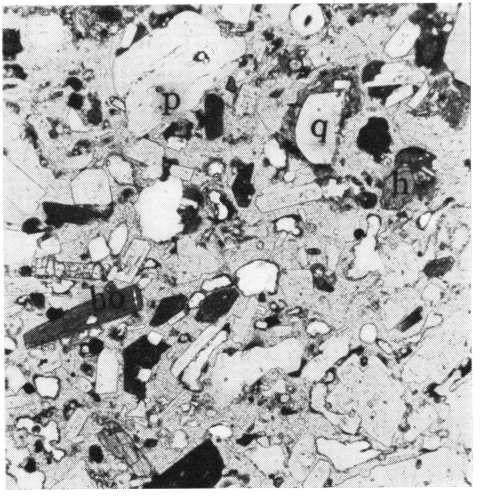


D.



T. KASAMA: Petrographic Notes, Nakano-sima, Tokara-islands.