PETROGRAPHIC NOTES ON THE VOLCANIC ROCKS FROM HARUNA, CENTRAL JAPAN PART III

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By

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Introduction

Succeeding to the writer's previous reports, the supplementary description is given in this paper on some rock-forming minerals of volcanic rocks from Haruna, Central Japan. As already mentioned, the majority of the rocks from Haruna is found to be of two rock types, the one type being hornblendic andesite and the other, pyroxenic andesite. The following description is concerned with the both rock types.

Acknowledgements

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I. Feldspar (II)

(1) Plagioclase in the groundmass: Plagioclase is the chief constituent mineral of the groundmass of the both rock types, the pyroxene-andesite and the hornblende-andesite.

The groundmass of the pyroxene-andesite is usually medium- or coarse-grained and may be termed pilotaxitic in texture. The plagioclase is lath-shaped or prismatic, varying considerably in size and amount. Not infrequently the Albite and Carlsbad twins and zonal structures are found, and in some cases the marginal zone is surrounded by the much sodic plagioclase (andesine (-oligoclase)) in crystallographic continuity. In some acidic types the marginal zone passes into the matrix. Moreover there are sodic plagioclase (andesine, oligoclase and anorthoclase) filling up the interstices between the laths and prisms of plagiocalse.

The groundmass of the hornblende-andesite consists of few microphenocrysts (laths of plagioclase, rods of hypersthene and grains of magnetite) and cryptocrystalline acid mesostasis (quartz, oligoclase, anorthoclase, hypersthene and tridymite).

Although the composition of prismatic plagioclase in the groundmass (microphenocryst in coarse-grained rocks) is variable in the pyroxene-andesite as well as in the hornblende-andesite, there is a tendency that in the former it is richer in Ab content than the phenocryst, while the relation is not so prominent in the latter. The relations are shown in the table and diagram. (Table I and Fig. 1).

(2) Anorthoclase: Anorthoclase occurs either interstitially between the plagioclase laths or as independent prismatic crystals in the coarse-textured acid matrix.

(3) Plagioclase apparentiy with small optic axial angle: In a specimen (hypersthene-and hornblende-bearing andesite, 39 III S. T. -72), on which descriptions are given in the later pages (page 4–6), are found plagioclase apparently with small optic axial angle.

It occurs as microphenocryst with ill-defined shape or semi-interstitially in the coarse-textured groundmass, together with andesine with rather larger optical angle. It is twinned in Carlsbad type. The contact of each side of the twinned plagioclase is very obscure and considered to be cut approximately parallel to the composition plane. The index of refraction is slightly higher

TABLE I An % in the plagioclase, measured by the maximum extinction angle in zone (010).

	Sample No.	Phenocryst	Sodic rim	Microphenocryst and groundmass	
Hornblende-andesite	10	78-55 —	(45)	(89) — 78 — 58	Oscillatory Zoning
	37	81-57 —	(53)	(89) — 78 — 56	
	48	78-50 —	(46)	(86) — 78 — 57	
	100	83-52 —		83 — 80 — 58	( ): Mark, showing rare occurrence.
Pyroxene-andesite	12 A	85-70 —		80 — 59	Normal Zoning
	56	93-61 —		(88) — 78 — 56	
	84	83-65 —		75 — 59	
	91	92-56 —		86 — 56	
	125	87 —	45	75 — 53 —	
	192	94-58		(87) — 78 — 51	
	272	92-72 —	58	86 — 53	

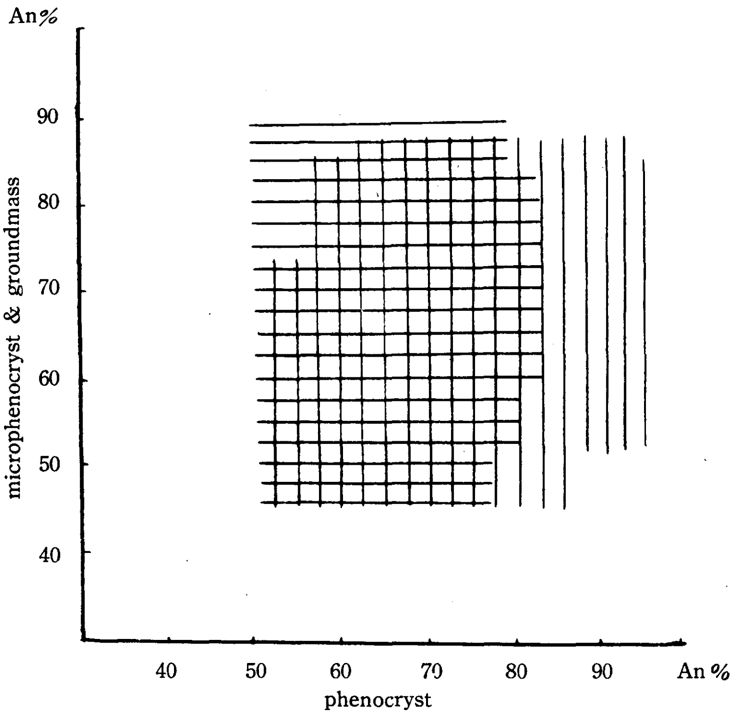

Fig. 1. Diagram showing the relation in composition of the phenocryst plagioclase to the microphenocryst and groundmass plagioclases. The sodic rims of phenocrysts that must be crystallized at a stage of the consolidation of the groundmass are belonged to the groundmass.

Horizontally hatched area is concerned with the hornblende-andesite and vertically hatched area with the pyroxene-andesite than that of quartz and the optic axial angle is small with (+)2V $=50°-59°$.

Though the optical properties correspond to those of the "Potash andesine",* from its orientation it seems to be a superposed plagioclase (andesine), ruled by the Carlsbad twin. It is considerable that similar modes of occurrence of plagioclase are not so extraordinary in the Haruna's rocks.

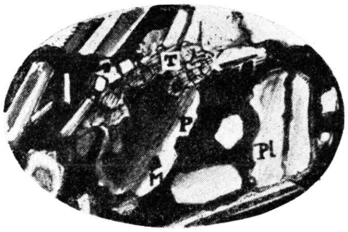

Fig. 2. Plagioclase (P). apparently with small optic axial angle.
T: tridymite, M: magnetite, Pl: plagioclase. (cross nicols)

* T. TOMITA, Geological and Petrological Study of Dogo, Oki, part 12 (in Japanese), Jour. Geol. Soc. Tokyo, XXX VIII, p. 413, 1931, and Olivine-trachyandesitic Basalt from Hsueh-hua-shan Hill, Ching-hsing District, Jour, Shanghai Sci. Inst., Sect. II, Vol. 1, No. 1, 1933.

K. SUGI, On the Nature of Some Plagioclase Apparently with Small Optical Angle, with Special Reference to the Plagioclase in Olivine-Dolerite from Fushun, Manchuria, Memoirs of the Faculty of Science, Kyūsyū Imperial University Ser. D, Vol. 1, No. 1, 1940.

II. Monoclinic Pyroxene (II).

Aegirine-augite *

The aegirine-augite occurs very rarely in a definite vein-like area and gas cavity in the groundmass.

(1) The former mode of occurrence is met with in a thin section of one of the lavas (Hypersthene- and hornblende-bearing andesite (39 III S. T.-72)) that constitute the older volcano. The rock contains the sporadic phenocrysts of zoned plagioclase (by-

townite-labradorite), pleochroic hypersthene and wholly opacitized hornblende. The texture of the groundmass may be termed pilotaxitic.

The laths and tables of plagioclase, and the prisms of hypersthene and augite show fluidal arrangement. Tridymite occurs interstitially, while minute grains of magnetite and ilmenite are scattered uniformly throughout the groundmass. Hypersthene, which exceeds augite in amount, varies in size from microphenocrysts to minute prisms. It forms parallel intergrowth with augite, the former being usually inside the latter, but in no case completely by the monoclinic pyroxene. The acid materials of the groundmass are collected in ill-defined patches and veins, the latter cutting the fluidal structure of the groundmass at nearly right angles. In such areas, flakes of pale greenish brown biotite, prisms of oligoclase, and a few hypersthenes are embedded in a matrix of quartz. Aegirine-augite occurs in a definite vein-like area, where it is associated with plagioclase and a few tridymite and anorthoclase, almost to the exclusion of magnetite and hyper-

Fig. 3. Hypersthene- and hornblende- bearing andesite (39 III S. T. - 72).
a—aegirine-augite. The upper side of the photograph is a hollow of the thin section. (× 80)

sthene. The plagioclase laths are arranged parallel to those in the adjacent area of the groundmass. Between the laths are found irregular-shaped grains of deep-green pyroxene, having the optical properties: $c \wedge z \fallingdotseq 76^\circ$, $(+)\,2V = 63^\circ - 78^\circ$, distinctly pleochroic with $X = Y =$ grass green, $Z =$ yellowish-brown.

(2) Another mode of occurrence was noted in a block of hornblende-bearing augite-hypersthene-andesite (39 III S. T.-75). In this rock, aegirine-augite occurs in a small patch in the groundmass. It appears that the mineral filled up an original gas cavity. The phenocrysts of hornblende are completely opacitized.

These features indicate that soda was concentrated in some parts of the groundmass, where the aegirine-augite was formed, partly replacing the pyroxenes and magnetite that had already been formed. Whether or not the origin of this soda is attributable to the opacitization of the hornblende is a question that cannot be answered from the result of the present observation, but it is decided that the aegirine-augite is a deuteric mineral and not a product of alteration by later hydrothermal solutions.

Fig. 4. Hornblende-bearing augite hypersthene andesite (39 III S. T.-75)
a—aegirine-augite, R—hypersthene, Pl—plagioclase. (× 95)

* This mineral was already reported in the preceding paper. In this part it was reprinted somewhat briefly. (H. KUNO & S. TANEDA, Occurrence of aegirine-augite in some andesites from Japan, Jour. Geol. Soc. Japan, Vol. 47, 1940).

The mode of occurrence of aegirine-augite in the hornblende-gabbroic secretions in augite-bearing hypersthene-hornblende-andesite form Isigami-Yama, near Kumamoto City, Kyūsyū, gives one the impression that its origin is related to the opacitization of hornblende. (H. KUNO, op. cit.)

III. Biotite

The mineral is hardly found throughout the lavas and essential ejecta, with the exception of rare minute flakes in the groundmass of few leucocratic rocks. The groundmass consists of the laths and tables of plagioclase and the prisms of hypersthene and augite showing fluidal arrangement, and the acid materials are collected in ill-defined patches and veins. In this acid area a few flakes of pale greenish brown biotite are embedded in a matrix of quartz, together with prisms of oligoclase, anorthoclase, and a few hypersthene.

IV. Magnetite

Magnetite occurs broadly as phenocrystic and groundmass minerals in the both rock types.

In the pyroxene-andesite, it varies in size, ranging from the grain of the groundmass, less than 0.003 mm., to the rather ill-defined octahedral phenocryst, up to 1.5 mm. in diameter and at sometimes is surrounded by the groundmass pyroxene. The amount is also variable, that is to say, the phenocryst of magnetite occupies about 2–4 % (Wt.), and the groundmass magnetite about 11–20 % (Wt.) of the whole groundmass.

In the hornblende-andesite the phenocryst of magnetite occupies about 2–10 % (Wt.) (usually 3–5 %) and the groundmass magnetite about 7–12 % (Wt.) of the whole groundmass. The size is also variable, but there is a slight gap between the phenocryst and the groundmass. The phenocryst is often octahedral, up to 1 mm. in diameter, and rarely includes minute rods of apatite and plagioclase. The mode of occurrence suggests that it was formed in the last stage of the crystallization of phenocrysts.

Although the grains of magnetite are scattering uniformly through the groundmass, at sometimes the dark area, where is accumulated very fine grains of magnetite densely, is found around the gas cavity in the groundmass. It seems to suggest that gas is the carrier of iron-oxides in the effusive condition.

Besides the magnetite above mentioned there are magnetite grains included in the hypersthene, augite, hornblende and rarely in the plagioclase. Some of them in the hypersthene and augite may be caused by the exsolution.

On the magnetite derived from olivine by the resorption and that concerned with the opacitization of hornblende, the descriptions were already given in the previous papers. (Part 1, IV. Apatite and Part II, IV. Olivine).

V. Glass

Glass occurs interstitially in very small amount, but in some scoriaceous varieties of pyroxene-andesite it is abundant, up to 50 %, and in pumice over 80 %.

The fresh pumice glass is usually colourless to yellow, but is sometimes dark due to impalpable inclusions (magnetite-like substance). In a few cases it is heterogeneous, that is partially pure and partially dusty. So far as the writer's observation goes, the index of refraction is usually 1.502–1.510, sometimes up to 1.520 in the dusty area, being recognized a tendency that the coloured part is higher than the colourless part in the refractive index.

Not infrequently the dusty area takes vesicular shape and seems to be representing the bubbles filled up by the ooze of the last residual magma. The refractive index of this area is about 1.537.

The glass of the pyroxene-andesite is of higher refractive index, with n about 1.520 in the light coloured one, especially up to 1.530–1.552 in the dark brown one.

The glass of the hornblende-andesite is uaully colourless and of lower refractive index with n about 1.510 in the dark part.

The values of refractive index are set into the table (Table II) and are illustrated in the diagram (fig. 5). They correspond to the glass with 72–53 % SiO_2 according to W. O. George.* In detail it is 72–63 % (n: 1.502–1.520) for the hornbldnde-andesite and 68–53 % (n: 1.508–1.552) for the pyroxene-andesite.

According to him the refractive index of the natural glass increases with increase in the iron-oxides, lime and magnesia contents in it, but it decreases with increase in the potash content. From the same data that W. O. George used, the writer constructed a diagram (Fig. 6) showing the relation of the refractive index to the ratios, Iron-oxides/Magnesia and Lime/Potash. In it are shown the relations that the ratio Iron-oxides/Magnesia decreases with increase in refractive index and the ratio Lime/Potash increases with increase in the latter. Consulting to the data above mentioned, it is estimated that the glass in the hornblende-andesite is higher in the silica and potash contents and the ratio Iron-oxides/Magnesia, and lower in the magnesia, lime, and iron-oxides contents and the Lime/Potash ratio.

* WILLIAM O. GEORGE, The relation of the physical properties of natural glasses to their chemical composition, Jour. Geol., Vol. 32, 1924.

TABLE II The refractive index of the glasses.

Sample No.	index.			
14α	1.502			
100 p	1.520–1.510	1.530 (vesicular dark area)		
119	1.502±0.002			
198	1.505–		Pumice	
200	1.504–			
276 p	1.508–1.520	1.537 (vesicular dark area)	Block	Hornblende-andesite
67	1.503±			
27B1	1.508		Bomb	
27B0	1.510			
175p	1.508–1.520		Pumice	Pyroxene-andesite
(192	1.521±		Lava)	
180	1.530	(dark brown)	Scoriaceous ejecta	
255	1.548–1.552	(dark brown)		

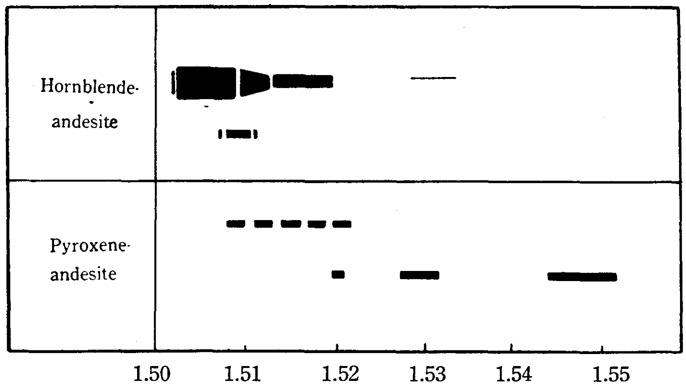

Fig. 5. Diagram showing the index of refraction of glass in hornblende-andesite and pyroxene-andesite from Haruna. In both the upper line is concerned with pumice and the lower one with bomb or scoriaceous lava. The thickness of the uppermost line gives a rough indication of the relative quantity of glass.

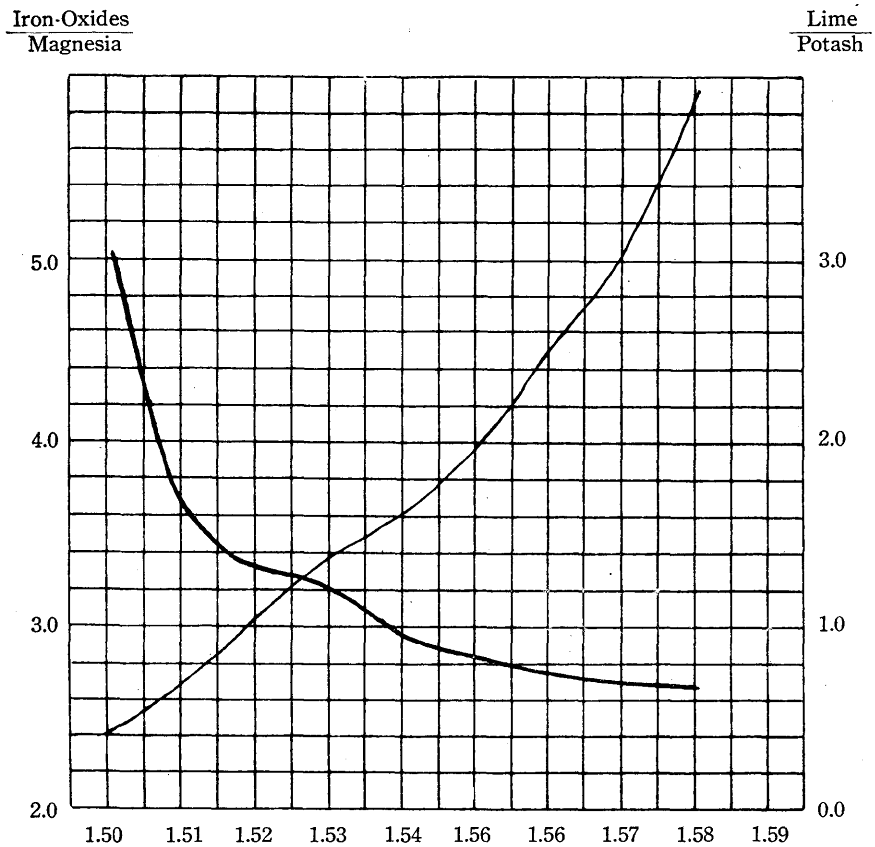

Fig. 6. Diagram showing the relations of the index of refraction to the ratios, Iron-oxides/Magnesia and Lime/Potash. (Ref. p. 9).

VI. Zeolite

(1) Zeolite occurs in a pyroxene-andesite that was altered by a later solution as a hot spring. The rock is frail and stained

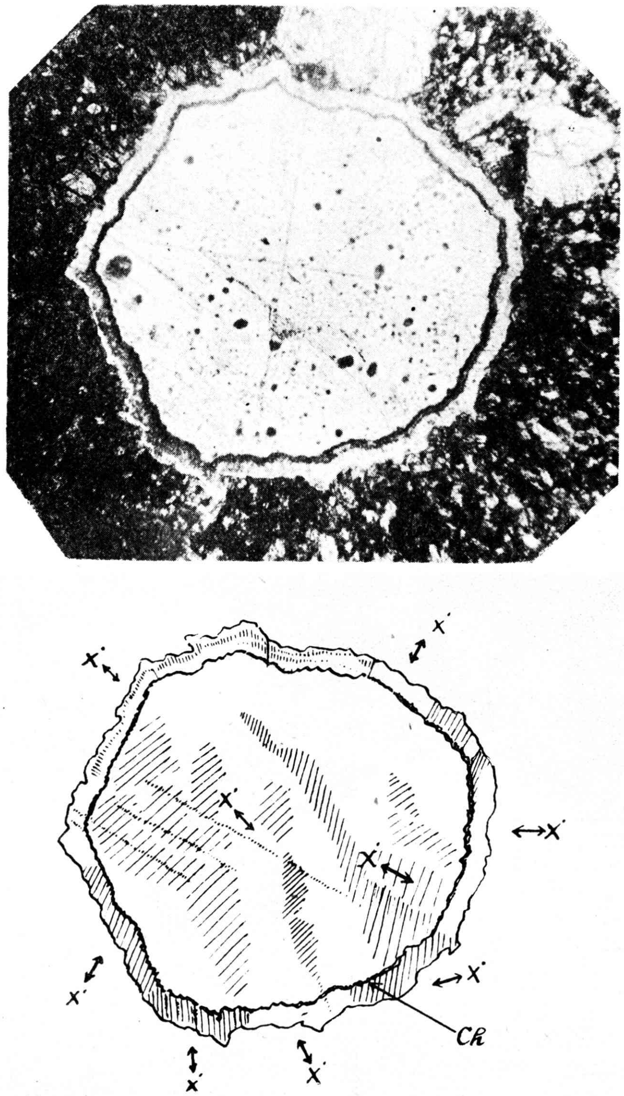

Fig. 7. Zeolite in the hypersthene-andesite
(39 III S. T. - 15) × 48
Ch—chlorite zone.

dark green or reddish brown, and including white spherical and irregular-shaped clots, usually 2–5 mm., sometimes up to 10 mm. in size. The former is the aggregates of zeolite crystals, fibrous to prismatic, often in spherulitic arrangement, and the latter is composed of calcite chiefly.

Under the microscope, phenocryst of zoned plagioclase, hypersthene and subordinate augite and magnetite are seen embedded in an altered groundmass. Plagioclase is often replaced by zeolite and chloritic matter along the fractures. Hypersthene is rimmed by the aggregates of monoclinic pyroxene and altered to the chloritic matter along the fractures. The groundmass is composed of laths of plagioclase, grains of pyroxene and magnetite, and alteration products (chloritic and zeolitic matters). It carries the amygdaloidal cavities, the walls of which are often mantled by zones of zeolite and chloritic substances, and the insides of which is filled wholly or partly with zeolite and calcite. The mode of occurrence of the zeolite is illustrated in Fig. 7.

Besides the zeolite above mentioned there are the aggregates of fibrous ones with chloritic matter in irregular-shaped veins or patches in the groundmass. (Fig. 8).

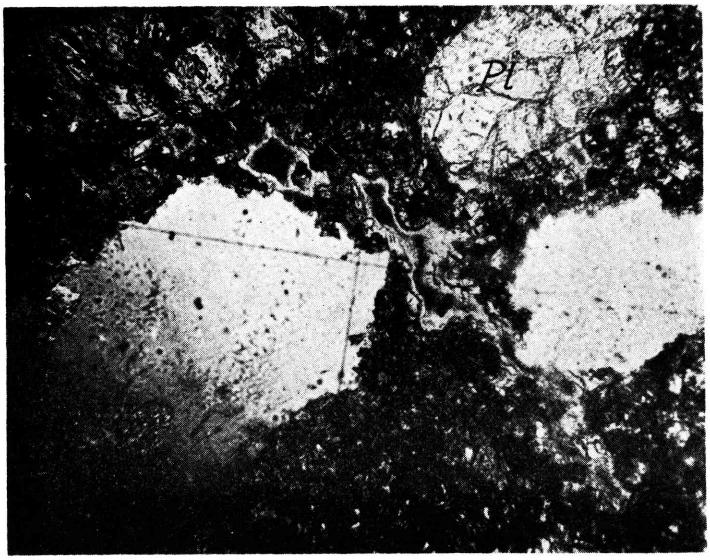

Fig. 8. Zeolite in vein, in the same rock as Fig. 7. (39 III S. T.-15)
Pl—plagioclase. × 56

From the mode of occurrence, the zeolites filling up the cavities as well as those of the groundmass, seem to be of an alteration product by later solutions.

The optical properties of the zeolite measured microscopically are as follows.

TABLE III

Zeolite, filling up the cavity.		Zeolite, constructing the mantle of the wall of the gas cavity.
α (min.) $=1.489$	± 0.002	Lower
$\beta=1.497-1.501$		
γ (max.) $=1.508$		
$(+)\,2V=55°\pm$		$(-)\,2V=$small
Op. pl. $\perp$ c-axis	Elongation $\pm$	
Straight extinction		Straight extinction

At the present, it is not decided whether it is a variety of thomsonite or not.

2) Another occurrece of zeolite is noted in a autolith in the hornblende-andesite from Somasan. The autolith is composed of zoned plagiolcse, opacitized hornblende (both vary in size), quartz

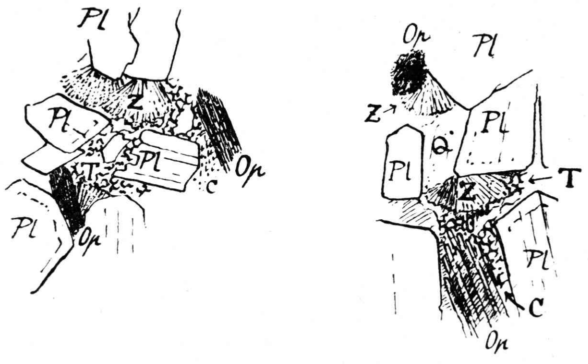

Fig. 9. Microscopical sketch showing the mode of occurrence of the zeolite in the autolith in Somasan lava.

Z—zeolite, T—tridymite, C—cristobalite, Q—quartz, Op—opacite and Pl—plagioclase.

and cristobalite with few tridymites. The quartz and cristobalite occur side by side interstitially, and sometimes the former is spherulitic and the latter is predominated around the gas cavities. Close by the plagioclase are found the spherulitic zeolite also, replacing the cristobalite or tridymite. It is brownish and about 1.511 in the refractive index and very low in the retardation. The mode of occurrence (Fig. 9) suggests that the zeolite is a deuteric mineral and not a product of alteration by later solutions.

VII. Ilmenite, Hematite, Calcite, Kaoline, Opal and Gypsum

These minerals occur rarely as the accessory mineral or secondary mineral. On these minerals no description is given in this part.