76. *Mica Basalt from Mutsuré-jima.*

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At the western entrance of the Shimonoseki Strait, which is a narrow channel separating Kyushu from the Main Island of Japan and connecting the Sea of Genkai with the Inland Sea, lies an islet called Mutsuré-jima with oval outline whose elongation direction 1200 m runs from north to south and the narrow part at the middle measures about 550 m. These two parts rise 398 m and 350 m respectively above sea-level. According to Y. Kawano in our Institute, who made a short visit to this islet, its foundation is composed of the Tertiary sediments and the formation is covered by a basalt flow, whose petrographic characters are interesting and are dealt with in the present paper.

The geologic age of the eruption of the basalt can not be told exactly at present but it seems probable that it belongs to the same period as that in which the basalt eruptions were repeated in a long area extending along the north-western coast of the Main Island of Japan and also the northern part of Kyushu. It also seems probable that the eruptions of these basalts are earlier than those of the acidic andesites which form huge volcanic cones arranged linearly along the coast of the Japan Sea in western Honshu, such as Dai-sen, Sambé, Aonoyama etc., and are later than those of rhyolites developed along the same coast.

Megascopic properties:—The Mutsuré-jima basalt is markedly characterized by a vesicular structure, the outlines of vesicles being generally irregular and sometimes elongated toward the direction the flow motion happened in the rock which was still in a semisolid state. Many thin flakes of dark brown mica are seen to traverse the vesicles and firmly connect the inner wall of the cavity with the edges of the crystal flakes. Besides this mineral, very slender crystals of hornblende, less than 3 mm × 0.5 mm, with well developed crystal faces, can also be observed in the vesicles, though its quantity is very small. In general, the hornblende crystals are firmly adhered to the inner wall of the vesicle, but sometimes the long crystal traverses the cavity like a bridge.

The material of the basalt is compact and fine grained as is seen in the usual basalt. As the megascopic phenocrysts, small grains of olivine are sporadically distributed in the groundmass.

Microscopic characters:—Under the microscope, the rock is holocrystalline and fine grained. Besides the olivine, a few crystals of plagioclase appear as microscopic phenocrysts. The groundmass consists

essentially of olivine, augite and plagioclase, with magnetite and apatite as accessories. Added to these ingredients which are common minerals forming the usual type of basalt, brown mica together with the smaller quantity of brown hornblende are abundantly observed in the vesicles or in the groundmass surrounding these cavities in much smaller quantity. As is seen

in microphotograph (Fig. 1), brown mica penetrates clearly into the outermost shell of a plagioclase crystal forming the groundmass. It is clear that the brown mica ended its crystallization before the ending of the crystallization of the plagioclase crystal. The case is the same for the brown hornblende. From these observations, it is evident that the

Fig. 1. Brown mica (*m*) in the vesicle (*v*) in basalt penetrates into the outermost zone of plagioclase (*p*) forming the groundmass. $\times 75$. Loc.: Mutsuré-jima.

brown mica and hornblende are primary ingredients, not secondary ones produced in the cavities by some secondary agencies.

The *olivine* phenocrysts show a subhedral form and some of them are altered into reddish brown material. The refractive indices of its fresh part, measured by an immersion method, are $\alpha' = 1.710$ and $\gamma' = 1.746$, indicating that in the chemical composition of the mineral about 33% of $\text{FeO} + \text{MnO}$ are contained.

The *augite* crystals appear only as a groundmass component. They are fine grains and fresh in material. The refractive indices are $\alpha' = 1.689$ and $\gamma' = 1.711$, showing that its chemical composition is approximately as $30(\text{CaFeSi}_2\text{O}_6) \cdot 70(\text{CaMgSi}_2\text{O}_6)$.

The *plagioclase* crystals may be classified into three varieties. One of which is the phenocrysts with a prismatic habit. The second is the groundmass plagioclase in a lath-shape. The third is the outermost shell surrounding the second variety and is the latest plagioclase filling the interstitial space in the groundmass. They are different in their refractive indices, such as:—

	Micro-phenocrysts	Groundmass plagioclase	Outermost shell
α'	1.567	1.564	1.531
γ'	1.573	1.571	1.537

From these indices, the chemical compositions of the 3 plagioclase varieties correspond to 74% of An, 69% of An and 6% An respectively.

Thermo-optic properties of brown mica and brown hornblende.

Brown mica:—As the optic axial plane of the mineral is parallel to (010), which was determined by the Laue photograph, the brown mica belongs to the meroxene type. The refractive indices, optic axial angle and absorption of light, measured at ordinary temperature are given as:

$$\alpha=1.557, \gamma=1.606, 2E=23^{\circ}\sim 32^{\circ}, Z < Y > X.$$

These refractive indices are much lower than those of the meroxene biotite usually found in andesites.

In our previous studies¹⁾ of the Sambé lavas, we have discovered that there are two distinguishable varieties in brown mica when we treat it thermo-optically, that is, the anomite type is stable thermally, while the meroxene type is unstable and changes its optical properties at temperatures higher than about 400°C. The Mutsuré-mica is stable thermally, and no special change in indices and in optic axial angle were noticed in the range of temperature between 20°C–1000°C (Table I). Hence we see that the Mutsuré brown mica is different from the meroxene biotite and its thermal property is similar to phlogopite. This character is clearly shown by its chemical analysis which will be described in a separate article.

TABLE I.

Temp. in °C.	2E	α	γ
20	22°	1.557	1.605
200	22	—	—
400	22	—	1.606
500	22	—	1.606
600	22	—	1.607
700	22	—	1.607
800	22	—	1.608
900	22	—	1.609
1000	22	1.555	1.608

Brown hornblende:—As we have already described elsewhere, brown hornblende can be distinguished in two varieties according to its thermal property, as in the case of biotite. One variety, which may be classified as the common brown hornblende, changes its optical properties rapidly at about 750°C, while the other which may be called

1) S. Kôzu and B. Yoshiki: Sci. Rept., Tohoku Imp. Univ., Series III, Vol. 3, p. 177.

the basaltic hornblende shows no change in its properties until 1000° C. The Mutsuré-hornblende does not show any change in refractive indices at 750° C and only a slight increase in the refractive indices was noticed at 900° C, the experimental results being given in Table II.

TABLE II.

Temp. in °C.	Ref. Index on (110)	Ext. Angle on (110)	Pleochroism seen on (110)
18 {	$\alpha'=1.643$ $\gamma'=1.655$	$c \wedge Z'=15^\circ$ (13°-17°)	Z'=light greenish brown X'=light brown
700 {	$\alpha'=1.644$ $\gamma'=1.656$	$c \wedge Z'=16^\circ$ (15°-17°)	Z'=light greenish brown X'=light brown
800 {	$\alpha'=1.644$ $\gamma'=1.656$	$c \wedge Z'=15^\circ$ (12°-17°)	Z'=light greenish brown X'=light brown
900 {	$\alpha'=1.646$ $\gamma'=1.659$	$c \wedge Z'=15^\circ$ (13°-17°)	Z'=light greenish brown X'=light brown

This thermal property of the Mutsuré hornblende is similar to that of the basaltic hornblendes in andesites from different localities, but its larger extinction angle varying from 12° to 17° measured on (110) and its lower refractive indices are different from the well known characteristics of the basaltic hornblende.

Chemical composition of the basalt:—The chemical analysis of the Mutsuré-basalt was made by Kishiro Endô in our Institute, the result is as seen under the column (I) in Table III. If we compare this result with the mean values of fifty-six analyses of basalts derived from the Pacific floor (III) and of eleven analyses of rocks from the Deccan traps (II), published by Washington, it will be seen that there is a remarkable likeness, with the only important difference a higher content of alumina in our basalt.

TABLE III.

	I	II	III
SiO ₂	48.01	50.61	50.06
Al ₂ O ₃	18.59	13.58	15.51
Fe ₂ O ₃	6.82	3.19	3.88
FeO	6.07	9.92	6.23
MgO	5.26	5.46	6.62
CaO	8.48	9.45	7.99
Na ₂ O	2.59	2.60	4.00
K ₂ O	1.86	0.72	2.10
H ₂ O	2.07	2.13	1.16
TiO ₂	0.48	1.91	1.96
P ₂ O ₅	0.33	0.39	0.25
MnO	0.12	0.16	0.15
residue	—	—	0.08
Total	100.68	100.12	100.00

- I Basalt from Mutsuré-jima. K. Endo anal.
- II Mean of eleven analyses of basalts from the Deccan traps (after Washington).
- III Mean of fifty-six analyses of basalts derived from the Pacific floor.