ON A ROCK OF NORDMARKITIC COMPOSITION FROM HAKUTÔ VOLCANO, KOREA

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With 2 Text-figures

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INTRODUCTION

The present paper from the petrographical viewpoint deals with an interesting rock sample which was recently presented to the writer by Prof. T. ITÔ in the Mineralogical Institute of the Tôkyô Imperial University. It is said that the sample was collected by Mr. H. YAMANARI, a former member in the Geological Survey of the Government-General of Tyôsen (Korea), from the summit of Hakutô volcano, which stands at the boundary of Korea and Manchuria, on the occassion of his exploring journey to the district in 1926.

According to H. YAMANARI,[1] the rock occurs there in irregular blocks, several centimeters to a few meters in the largest diameters. Such blocks are widely scattered from the summit to the skirts of the volcano, accompanying rock blocks of numerous kinds of volcanics, such as pitchstone, alkali-trachyte, pumices, obsidian, basalt and some porphyritic rocks. His observation states the larger blocks are generally found in the neighborhood of the summit and the smaller ones are at the lower skirts of the mountain. Mt. Hakuto, 2750 m. in highest peak, is a comparatively young strato-volcano with a caldera lake Tenti, 4 km. in diameter, on its summit. Appearances suggest that the volcanic activity has been quite recent, although there are no exact historical records, only the uncertain trandition of eruptions in 1597 and 1702.

(1) H. YAMANARI: Jour. Geogr. Soc. Tokyo, **40** (1928) 158.

Numerous recent descriptions[1] on the geology and petrography of Hakutô volcano show that it is chiefly composed of alkali-trachyte flows, including such types as porphyritic fayalite soda-diopside anorthoclase trachyte (so-called hakutoite), fayalite bearing soda-diopside aegirine-augite anorthoclase quartz trachyte and hyalopantellarite, and their tuffs, which are covered by the younger basalt flows and commenditic pumices.

The rock blocks, in the subject of this paper, as well as the other new volcanic detritus, cover the whole surface of the volcano and are believed to have been ejected from the main crater on the occasion of its latest explosion. The specimen at hand is typical holocrystalline alkali rock with syenitic appearance composed of various interesting constituents. Of this rock, some special minerals have been lately described by Mr. N. KATAYAMA,[2] but the properties of the whole rock itself have not been reported.

Glancing at the volcanic regions in Japan and Korea, blocks of holocrystalline igneous rocks, have been reported by many authors to occur as cognate or accidental xenolith from various volcanoes. Of many examples, the following are noted: granitic rocks from Sakurazima,[3] Kaimon[4] and Ôsumi[5] of Kyûsyû, Nantai[6] of Totigi Pref., Saisyû-island[7] of Korea, and from Sikotuko,[8] Hokkaidô, dioritic rocks from Kôzusima[9] in the Fuji volcanic zone, and north-eastern part of Formosa,[10] syenitic rock from Iôzima[11] in the Fuji

(1) E. AHNERT: Journey through Manchuria (1904). S. KOZU: Chikyû, **7** (1927) 202. S. KOZU and K. SETO: Jour. Geol. Soc. Tokyo, **29** (1922) 211, and Proc. 4th Pan-Pacific Sci., Congr. **2** (B) (1929) 1067, H. YAMANARI: Jour. Geol. Soc. Tokyo, **34** (1927) 474, and Jour. Geogr. Soc. Tokyo, **40** (1928) 507, A. LACROIX: Compt Rendus des Sciences de L'Akad. des Sci. **135** (1927) 1410, and Bull. Geol. Soc. China, **7** (1928), T. TOMITA: Jour. Geol. Soc. Tokyo, **39** (1932) 203, T. WATANABE: Bull. Volc. Soc. Japan, **2** (1934) 40, T. NEMOTO: Journ. Jap. As. Petr. Min. Econ. Geol., **14** (1936) 154, etc.

(2) N. KATAYAMA: Beiträge zur Mineralogie von Japan, Neue Folge **2** (1937) p. 86 and 94.

(3) B. KOTÔ: Jour. Coll. Sci. Imp. Univ. Tokyo, **38** (1916), K. YAMAGUTI: Jour. Geol. Soc. Tokyo, **35** (1928) 157.

(4) B. KOTÔ: Ibid.

(5) K. YAMAGUTI: Jour. Geol. Soc. Tokyo, **36** (1929) 102.

(6) Y. SAITÔ: Bull. Seism. Soc. Japan, **27** (1899) 34.

(7) K. HARAGUTI: Tikyu, **12** (1929) 34, 94.

(8) Personal Correspondence of T. SIMOTOMAI.

(9) H. TUYA: Bull. Earthq. Research Inst. **7** (1929) 286, T. TUZIMURA: Bull. Earthq. Inv. Comm., **89** (1918) 68.

(10) HUNAKOSI: Chikyû, **21** (1934) 209.

(11) H. HOMMA: Ibid. **4** (1925) 307.

volcanic zone, micro-allivalite and microdiorite from Ôsima(1) in the same volcanic zone, etc.

As far as the writer is aware, a detritus of typical alkali syenitic rock has not previously been reported from elsewhere in the volcanic regions in Japanese Empire. For this reason, some short description on the petrography of the additional type from Hakutô-san is now placed on record.

PETROGRAPHICAL NOTE

The specimen is a medium grained equigranular rock of light grayish colour with leucocratic appearance. It is characteristic that there develop numerous miarolitic cavities in the rock. The main constituents of the rock are sub-idiomorphic in form, though some of them show a very fine crystal form in the cavities. Under the microscope the specimen proves to consist almost entirely of alkali-feldspars, accompanied with comparatively small smounts of quartz, barkevikite, aegirine, aenigmatite, fayalite and some other accessory minerals, such as magnetite, ilmenite, apatite, zircon, etc. When determined in thin sections for the homogeneous part, under the integrating stage, the average volume proportion of the constituents in the rock samples is as follows:

	volume %
Alkali-feldspars	74.67
Quartz	9.22
Barkevikite	8.66
Aegirine	4.30
Aenigmatite	0.85
Fayalite	0.97
Accessories	1.33
	100.00

As stated above, the mineral composition of the rock shows that it may be identified as belonging to quartz alkali syenite, nordmarkite. But from the textural point of view, it is not exactly plutonic or volcanic, showing an unusual type of rock. It seems probable that the rock may petrographically show an almost similar appearance to

(1) S. Tsuboi: Jour. Coll. Sci. Imp. Univ. Tokyo, **43** Art. 6, 98–101 (1920).

the syenitic rock from Kensan, Kankyôhokudô which has been described in detail by T. Itô.(1)

Two kinds of alkali-feldspar are recognizable in the rock: orthoclase and albite. The orthoclase crystals form three fourths of the rock and are generally tabular in shape 2~5 mm. in long diameter. Most of the mineral crystals show fine perthitic structure and are slightly decomposed to sericite and kaolinaceous matter. The crystals are usually untwinned, though some show twinning after the Carlsbad law. The mineral is negative and its optic axial angle is $(-)2V =$

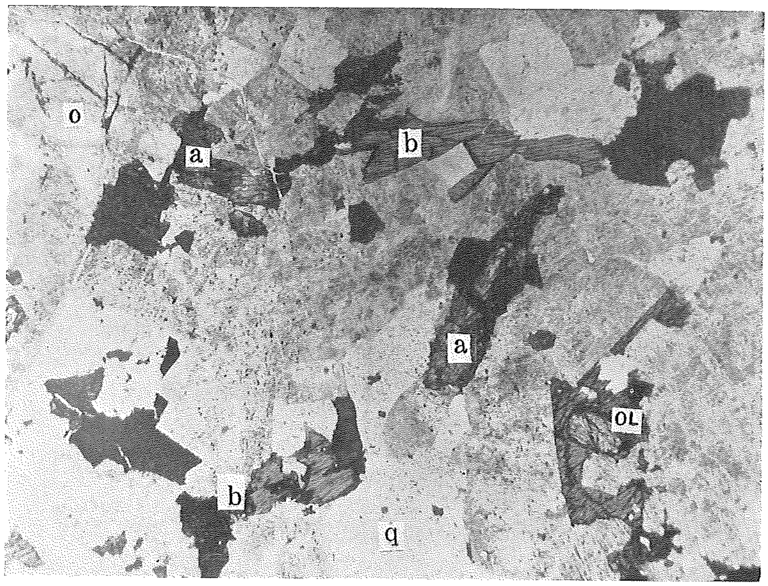

Fig. 1. Rock of nordmarkitic composition. ×22, o: orthoclase, q: quartz, b: barkevikite, a: aegirine, ol: fayalite.

62° determined with the universal stage. Albite crystals are found not very abundantly in the rock. They are usually subhedral with an average size of them is 0.4 mm. Twinning after the albite laws is very common, but zoning is almost absent. Under the universal stage $(+)2V = 76°$, the inferred composition is Ab_{97}.

Quartz occurs as xenomorphic form and fills up the interspaces of the other constituents indicating that it was the last product during the consolidation of the rock. It is always clear though partly it contains fine dusty materials as inclusions.

(1) T. Itô: Beiträge zur Mineralogie von Japan, Neue Folge **2** (1937) 147.

Barkevikite is the most important coloured mineral in the rock, occupying nearly nine per cent of the rock. It is usually subhedral, elongated along the vertical axis. The crystals of the mineral in the miarolitic druses, are very good and larger ones reach one mm. long or more. Detailed studies of the mineral were recently made by N. KATAYAMA,[(1)] who determined the crystal faces of it by the goniometrical examination as follows: m(110), p($\bar{1}$01), a(100), b(010) and uncertain r(011) and t(101). The optical axial plane is parallel to (010) and the character of the mineral is negative. The maximum extinction angle on (010) is $Z:c = 8°$ in obtuse $\angle \beta$ and the axial angle is nearly 0°, determined with the universal stage. Pleochroism is distinct in thin section;

X = light brown or light greenish brown.

Y = dark brown.

Z = dark brownish green.

Absorption is $X < Y < Z$

Refractive indices in (110) by mean of immersion method are $n_1(\mathrm{D}) = 1.693$, $n_2(\mathrm{D}) = 1.703$. Zonal structure is often observed and the fine inclusion of magnetite and zircon is not uncommon. It is worthy to note that the mineral is partly altered with the production to aegirine. In this case both minerals, barkevikite and aegirine, generally show fine intergrowth, having a common optic axial plane parallel to (010).

Aegirine is one of the essential mafic mineral, next to barkevikite in the rock. In general it regularly intergrowns with barkevikite crystal as has already been stated, but sometimes it occurs as an isolated crystal of short prismatic form, 0.3～0.4 mm. in long diameter. From its occurrence, it is obvious that the mineral here appears to be not primary in origin in magma but to be an altered product from barkevikite. The crystals in miarolitic druses reach 1～2 mm. in length and according to N. KATAYAMA,[(2)] they show the following crystal faces: m(110), a(100), p($\bar{1}$01), u(111), s($\bar{1}$11) and b(010). Cleavage along (110) is distinct and the twinning on (100) is frequent. In thin section the mineral occurs as pale green, sometimes colourless, crystals with darker tints of green or greenish brown towards their marginal parts. Under polarized light, it exhibits, a

(1) N. KATAYAMA: Loc. cit. pp. 94–96.
(2) N. KATAYAMA: Loc. cit. pp. 86–87.

pronounced zonal structure. There is a distinct pleochroism according to the sheme:

$$X = \text{grass green}$$
$$Y = \text{light green}$$
$$Z = \text{light brownish green}$$

Absorption formula is $X > Y > Z$. When the mineral intergrows together with barkevikite, the optic axial plane of the former almost coincides with that of the latter. The extinction angle in the zone of the cleavage is $X : c = 0 \sim 4°$ and $(-)2V = 70°$. Dispersion is $\varrho > v$. The refractive indices in (110) were determined by the method of matching in immersion media. The results are $n_1(\mathrm{D}) = 1.743$ and $n_2(\mathrm{D}) = 1.765$.

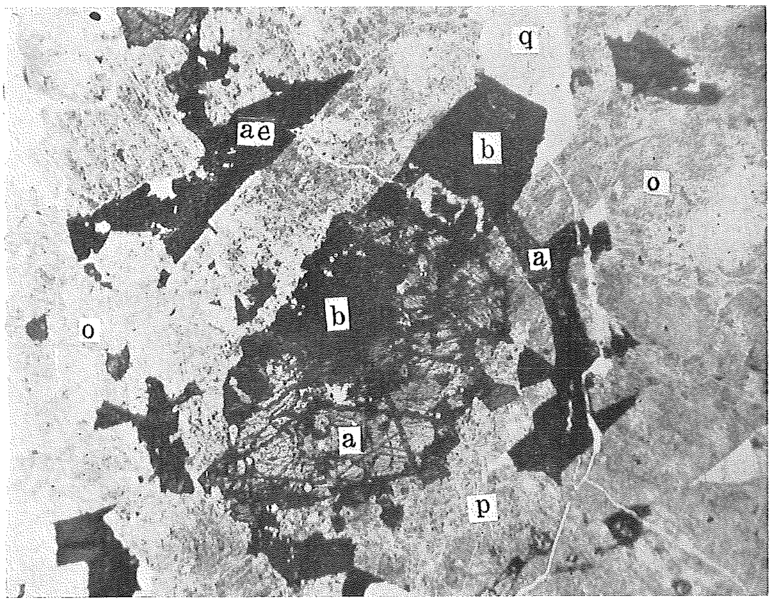

Fig. 2. Rock of nordmarkitic composition. × 17, o: orthoclase, p: albite, q: quartz, b: barkevikite, a: aegirine, œ: aenigmatite.

Aenigmatite is not very abundant in the rock. It occurs usually as irregular small grains although fine and comparatively large crystals can be seen in the miarolitic druses. It is almost non-transparent in thick section, but pleochroism is characteristic in thin section:

X = yellow brown

Y = castanian brown

Z = deep brown to black

Very strong absorption is shown the following optical data are obtained with difficulty. The optic axial angle is very small and the character of the mineral is positive. The maximum extinction angle is 37°. The retardation is comparatively low. As many good crystals of the mineral in the miarolitic druses, were collected by H. YAMANARI and they are now being prepared for examination by him, it may be expected that detailed studies of the mineral will be published in the near future.

Fayalite is sparsely distributed in the rock and occurs usually as an inclosure in the other mafic constituents. It shows a small euhedral or subhedral crystal, 0.2～0.3 mm. in diameters, with light colour. As it occurs usually as a small crystal, no accurate data on optical properties are obtainable in a mineral.

Accessory constituents, such as magnetite, ilmenite, zircon, apatite, are scattered throughout the rock samples being enclosed in feldspar and coloured minerals. They form generally minute crystal grains and show no specialitites to note here.

CHEMICAL COMPOSITION

The chemical analysis was very kindly made for the writer by Mr. T. NEMOTO, lecturer in the Geological and Mineralogical Department in the Imperial University of Hokkaidô, upon a specimen representative of typical homogeneous part of the rock whose petrographical characters have been described in the preceding pages. The results are given in Table I. The chemical compositions of the barkevikite bearing aegirine granites(1) from Tyôhakumen. Kankyôhokudô, and analcime acmitic-diopside syenite(2) from Kengan, Kankyôhokudô, Korea, which are found on the southeastern area of the Hakutôsan volcanic district, are cited in the same table, for comparison.

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(1) Y. KINOSAKI: Geological Atlas of Chosen, No. 14 (1932) 14 and T. TOMITA: Jour. Geol. Soc. Tokyo. **39** (1932) 721.

(2) T. ITÔ: Loc. cit. p. 151.

TABLE I.

wt%				Niggli Value			
	I	II	III		I	II	III
SiO_2	66.28	66.00	60.27	si	271	270.5	203
TiO_2	0.40	0.23	0.26	al	35.5	29.0	35.0
Al_2O_3	14.86	11.94	17.38	fm	19.5	28.0	22.5
Fe_2O_3	2.26	3.90	4.45	c	7.5	10.0	11.0
FeO	2.92	2.89	1.83	alk	37.5	33.0	31.5
MnO	0.10	0.15	0.15	k	0.32	0.55	0.335
MgO	0.34	0.92	1.03	mg	0.10	0.20	0.235
CaO	1.66	2.16	3.01	al-alk	−2.0	−4.0	3.5
Na_2O	6.34	4.55	6.27	c/fm	0.33	0.35	0.49
K_2O	4.73	5.55	4.77	ti	1.23	7.0	6.0
P_2O_5	0.10	tr	tr	p	0.24	—	—
$H_2O(+)$	0.13	—	0.72				
$H_2O(-)$	0.09	0.33	0.67				
SO_3	—	0.42	—				
Ig. loss	—	0.50	—				
Total	100.21	99.54	100.81				

I. Rock of nordmarkitic composition (block) from the summit of Hakutosam volcano, Kankyôhokudô, Korea (Analyst, T. Nemoto).

II. Alkaligranite from Teito, Tyôhakumen, Kankyôhokudô, Korea (Analyst in the Geological Survey of Korea).

III. Syenite from Kensan near Meisen, Kankyôhokudô, Korea (Analyst. S. Koike).

Inspection of the three analyses reveals close similarity in alkali amounts, although the rock from Hakutôsan is slightly richer in alumina and soda, and poorer in lime, ferric oxide and kali than the Sanmensan rock. The amount of silica is practically the same in both rocks but comparison brings out the remarkable fact that the former is poorer in normative quartz and possess a more sodic feldspar, as indicated by the ratio of total albite to orthoclase. The rock from Hakutô volcano shows a high content of silica and a low content of alumina, ferric oxide and lime, compared with the analysis of the rock from Kensan. It is noticeable that the (al-alk) value in the rock from Kensan is positive but those from Hakutôsan and Sanmensan are the reverse. The extremely low value of mg may be due to the fact that the coloured minerals in the rock from Hakutô volcano are of the usually iron-rich type.

SUMMARY

In short the rock block collected from the summit of Hakutô volcano, is an unusual type of rock of nordmarkitic composition. As is stated before, the rock is known only in the form of separated blocks, which are widely scattered over the surface of the volcano, from the summit to the foot. It is clear that these blocks are ejected materials generally derived from the internal rocks of the volcano, but further question remains as to the petrological origin of the blocks themselves. It may be one interpretation to regard them as cognate xenolith which are genetically related to the Hakutôsan lavas. It is, however, more probable to consider that they were directly derived from the lower seated rock which was poured out, as a precursor, prior to the eruption of the main effusives of Hakutô volcano. From many geological evidences the similar alkaline rocks seem extensively to distribute not only under the volcano but in the neighboring area of it.

In conclusion the writer desires to express his sincere thanks to Prof. T. Itô of the Tôkyô Imperial University who kindly presented the valuable sample to the writer. Thanks are also due to Mr. T. Nemoto who has made the chemical analysis of the rock for the author.