Jour. Fac. Sci., Hokkaido Univ., Ser. IV,
vol. 16, no. 4, Feb., 1975, pp. 501-510.

LATE NEOGENE BASALTIC ROCKS FROM THE KITAMI-MONBETSU DISTRICT, NORTHEAST HOKKAIDO

by

Yoshio Ōba

(with 3 Figures and 3 Tables)

(Contribution from the Department of Geology and Mineralogy,
Faculty of Science, Hokkaido University, No. 1384)

Abstract

Many small bodies of the late Neogene basaltic rocks, which consist of olivine basalt, augite olivine basalt, and basaltic andesite, are developed in the Kitami-Monbetsu district, northeast Hokkaido. Chemical composition of the basaltic rocks is similar to that of the Kuno's high alumina basalt series, though being not so high in alumina; it is transitional between tholeiitic, alkalic, and high alumina basaltic types. In the northern part, a bimodal volcanism of more alkalic olivine basalts and rhyolites is characteristic, while in the southern part, less alkalic basalts associated with andesites are predominant.

Introduction

The characteristic features of the occurrence of the late Neogene basalts in Hokkaido was first noted by Hunahashi (1950, 1953), who considered that the basalts were erupted at a limited period of Neogene, and that two contrasting types of basalt existed in different regions. Since then the basaltic rocks in the western part of central Hokkaido were studied by Satoh (1961), Ōba and Tagami, (1966) and Ōba (1968, 1971, and 1972). On the contrary, in the northeast Hokkaido, no systematic petrological investigation on basalt has been carried out. However, a number of lavas and dikes of the late Neogene basaltic rocks have been reported from the Kitami-Monbetsu district, northeast Hokkaido. The occurrence of these basaltic rocks is described in several 1:50,000 geological maps (Hasegawa and Watanabe, 1964; Kuroda and Teraoka, 1964; Nagao, 1968; Nochi et al, 1967; Sako et al, 1964; Sawamura and Hata, 1965; Suzuki and Asai, 1963; and Yamada et al, 1963), 1:100,000 geological map (Takeuchi, 1942), and in papers by Urashima et al, (1953), Urashima and Hariya, (1954) and Metal Mining Agency of Japan (1969). In this paper, the mode of occurrence, petrography and chemistry of the late Neogene basaltic rocks from the Kitami-Monbetsu district, are presented.

Table 1. General stratigraphic sequence and age of the basaltic volcanism in the Kitami-Monbetsu district.

age \ area			Monbetsu (Nagao, 1968)	Konomai & Numanoue (M. M. A. J., 1969)*		Saromako & Sanribanya (Kuroda & Teraoka, 1964)	Maruseppu (Nochi et al, 1967)
Tertiary	Neogene	Pliocene	Onishi F.	Shanafuchi G.	Upper		Yahagi F.
					Lower		Tomuirubeshibe F.
			?				
		Miocene	Mookoppe F.	Konomai G.	Upper	Chirai F.	Urashimanai F. Upper Lower
					Middle	Tokoro F.	
					Lower		Kamishiyubetsu F.
	Plaeogene						
Pre-Cretaceous			Shokotsu F.	Hidaka S. G.		Saroma G. Nikoro G. Yubetsu G.	Hidaka S. G.

* M.M.A.J. = Metal Mining Agency of Japan.

Geological Setting

The Kitami-Monbetsu district, northeast Hokkaido, is situated on the north of southwestern extreme of the Kurile island arc. This district represents a part of the "Green-tuff region" where intense volcanic activity has been taken place since Miocene time. The earlier volcanism which was taken place in Miocene, is characterized by eruptions of intermediate to acidic rocks, ranging from andesite to dacite. The later volcanism occurred in Pliocene, however, is represented by a bimodal association of basalt and rhyolite which developed typically in the northern part of this district. The stratigraphic sequence and age of the basaltic volcanism in this district are represented in Table 1, which was compiled from the previous geological investigations.

The late Neogene basaltic rocks occur within a north-south trending Tertiary basin between two basement rocks; to the east, the Tokoro-Toyokoro belt which consists of pre-Tertiary sedimentary and volcanic rocks, and to the west, geosynclinal deposits of the Hidaka Super Group are developed (Fig. 1). The basaltic rocks occur as lava flows, cones, and dikes which form the young topographic feature in the area.

Outcrops which clearly show the relation between the basaltic rocks and Neogene formation, are rather rare in this district. An example is found at Shanafuchi, 10km west of Engaru, where a lava flow of olivine basalt intercalates with and overlies the basal conglomerate of the Shanafuchi Formation of Pliocene. Another example is a drilling record at the southern

Table 1. (continued)

Ikutawara (Yamada et al, 1963)	Kitamifuji (Sako et al, 1964)	Rubeshibe (Sawamura et al, 1965)	Shotoshibetsu (Suzuki et al, 1 963)	Tsunemoto (Hasegawa & Watanabe, 1964)
Yahagi F.	Yamato F.	Volcanic rocks	Nitomamugawa F. Kohoku volcanic rocks Tomamugawa lava Kunnebetsugawa lava	Nakayama lavas Kumaushiri lavas Ukobio lavas
	Takinoue F.			Horokatokoro W. T.
	Onneanzuzawa F.	Komatsusawa F.	Tokachi F. / Bunsen F. Rawan cong. & sand s.	Onneanzuzawa F.
	Kamikinka F. ?		?	Tokorogawa F. ?
Toyohara F.	Tomuirubeshibe F.	Ainonai F.	Propylite	Nukanan W. T.
	Kitamifuji F.	Oketo andesite		Birikabetsu W. T.
Ikutawara F.		Oketo F.		Nikorkorogawa F.
	Kamishiyubetsu F.	Onne rhyolites		Kamishiyubetsu F.
		Rikubetsu F.	Rikubetsu F.	
Nikoro F. Yubetsu F.	Hidaka S. G.	Nikoro F. Yubetsu F.	Shotoshibetsu F.	Hidaka S. G.

Heavy vertical lines indicate the age of the basaltic rocks.
F. = formation W.T. = welded tuff S.G. = super group

part of Uehara-pass 5km south of Konomai mine, which indicates that a lava flow of basalt covers the Pliocene rhyolite.

Petrographical Features

The basaltic rocks from the Kitami-Monbetsu district are classified into the following five groups according to their mineralogical composition. Alteration of the basaltic rocks is generally weak; olivine phenocrysts are sometimes typically serpentinized, and secondary chlorite is common in the groundmass.

*Olivine basalts of type IIIb** (Locs. A, B, C, and D in Fig. 1; Analyses 1, 3, 4, 5 and 7 in Table 2)

Rocks from Monbetsuyama (Loc. A) and Kamifumi (Loc. C) are typical specimens. They are compact and dark olive grey or black in color. Olivine, up to 2mm in diameter, is the only mafic mineral, and plagioclase phenocryst is not common and rare in Nos. 1, 3, and 7. A specimen from Monbetsuyama contains 4.5% of olivine and 0.5% of minute plagioclase phenocrysts. Olivine occurs as stubby, poorly terminated, embayed prisms and without a pyroxene reaction rim. The groundmass has an intergranular or interesertal texture, and consists of tabular or lath-shaped plagioclase, 0.3 – 0.5mm in diameter, olivine, augite, magnetite, secondary chlorite and serpentine.

Augite olivine basalt of types IVb and IVc (Locs. B, E, J, and K in Fig. 1; Analyses 2 and 6 in Table 2).

* Kuno's (1950) rock type classification based on the ferromagnesian silicate mineral assemblage.

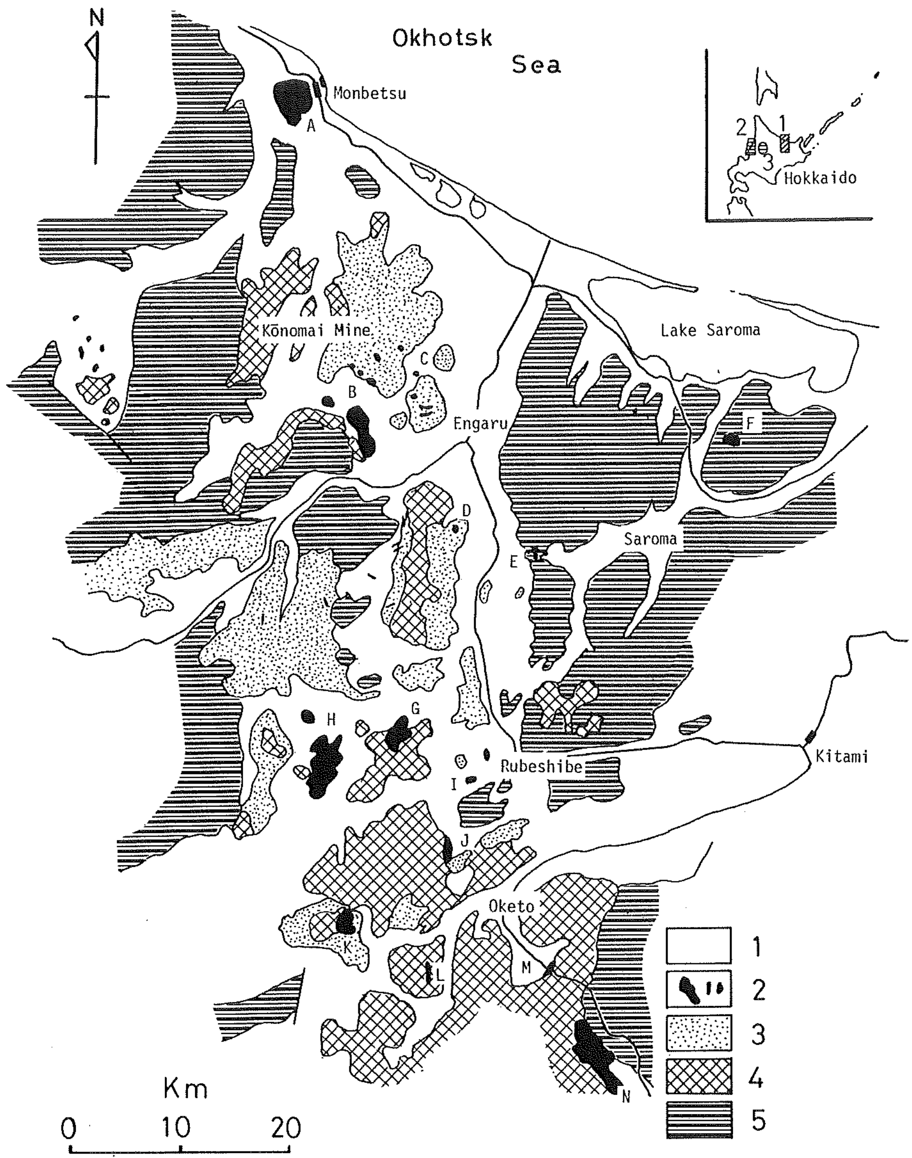

Fig. 1. Generalized geological map of the Kitami-Monbetsu district, northeast Hokkaido. 1: Tertiary and Quaternary sediments, 2: Basaltic rocks, 3: Rhyolites, 4: Andesites, 5: Pre-Tertiary basement. (Nos. 2, 3, and 4 are Tertiary volcanic rocks). Index map; 1: Kitami-Monbetsu district, 2: Kabato mountains, 3: Takikawa-Fukagawa basin.

This type of basalt occurs as isolated flows or is associated with the above mentioned olivine basalt. The rocks are compact and dark grey in color, and sometimes olivine phenocrysts are visible by the naked eye. Augite is subordinate to olivine, and plagioclase is sometimes abundant. Specimens from localities J and K contain 1.1% and 12.1% of Plagioclase, 0.8% and 5.7% of augite, and 4.5% and 7.1% of olivine phenocrysts, respectively. The former includes a small quantity of quartz xenocrysts which are rimmed by augite grains. Groundmass has an intersertal texture, and consists of lath-shaped plagioclase, olivine, augite, magnetite, glass, and secondary chlorite.

Aphyric (nonporphyritic) basaltic andesite (Locs. B, F, I, and H in Fig. 1; minor dikes in Fig. 1; Analyses 8 and 9 in Table 2)

The basaltic rocks of some minor lava flows and many small dikes belong to this type. The rocks are compact and dark grey to black in color. They are generally free from phenocrysts, but rarely include minite plagioclase and augite phenocrysts. The groundmass has an intersertal or pilotaxitic texture. A specimen from the northeast of Saroma (Loc. F) consists of lath-shaped plagioclase, 0.2 – 0.3mm in diameter, grain augite, magnetite, and some glass, with a few plagioclase microphenocryst.

Olivine-bearing augite basaltic andesite or andesite of types IVc and Vc (Locs. L,M, and N in Fig. 1; Analysis 10 in Table 2)

Rocks of this type have been called basalt in the field, because they are compact and grey or dark grey in color. The rocks are rich in plagioclase phenocryst, up to 5mm in diameter, which contains dusty inclusion in inner zone. Hypersthene, surrounded by granular augite, is not uncommon. The groundmass has an intersertal or hyalopilitic texture and consists of lath-shaped plagioclase, augite, magnetite, and glass.

Petrochemistry

Nine new chemical analyses of the basaltic rocks from the Kitami-Monbetsu district, and an analysis of the basalt from Asahi-pass (Loc. E, Fig. 1, by Yamada et al, 1963) are presented with their normative minerals in Table 2. The range of the silica content is 49–54% in basalts, and about 56% in basaltic andesites. The contents of normative olivine or quartz of the basaltic rocks, except for the more silicic basaltic andesites (Nos. 9 and 10), are generally small.

The chemical compositions of the basaltic rocks are plotted in an alkalis-silica diagram, in which the Pliocene basalts from the western part of central Hokkaido (Ōba, 1972) are also shown for comparison (Fig. 2). Although they are slightly lower in alumina, the basaltic rocks from the

Table 2. Chemical composition of the basaltic rocks from the Kitami-Monbetsu district, northeast Hokkaido.

Oxides	1	2	3	4	5	6	7	8	9	10
SiO_2	49.17	49.30	49.15	50.09	50.81	50.98	51.69	53.90	56.23	56.88
TiO_2	1.46	0.87	1.09	1.53	1.46	1.01	1.07	0.74	1.20	1.08
Al_2O_3	16.14	17.05	15.06	16.82	15.90	16.65	15.13	17.08	16.16	16.34
Fe_2O_3	2.04	3.20	4.92	2.63	3.46	2.86	2.63	3.96	1.40	3.64
FeO	7.41	6.44	6.22	7.01	7.57	6.81	7.05	6.93	5.87	5.61
MnO	0.11	0.22	0.20	0.11	0.10	0.23	0.18	0.19	0.21	0.14
MgO	7.29	8.09	6.98	6.20	5.70	8.04	6.91	4.03	4.61	2.41
CaO	9.53	10.20	10.47	8.88	9.91	9.20	8.04	7.46	9.23	6.83
Na_2O	3.34	2.28	2.81	3.43	3.00	2.53	3.42	4.18	3.14	3.51
K_2O	0.58	0.45	0.36	0.66	0.40	0.61	0.72	0.80	0.94	1.62
P_2O_5	0.25	0.19	0.21	0.24	0.15	0.19	0.29	0.37	0.11	0.24
H_2O (+)	0.75	0.86	1.59	1.10	0.28	0.34	1.73	0.23	0.70	1.36
H_2O (−)	1.19	0.91	1.01	0.88	0.91	0.20	0.93	0.46	0.28	0.54
Total	99.26	100.06	100.43	99.58	99.62	99.65	99.79	100.33	100.08	100.20
Normative minerals										
Q	−	0.26	1.78	−	2.68	1.28	1.06	3.61	8.24	11.80
Or	3.45	2.67	2.17	3.89	2.39	3.61	4.28	4.73	5.56	9.56
Ab	28.27	19.28	23.74	28.98	25.36	21.38	28.92	35.32	26.51	29.65
An	27.29	34.92	27.36	28.52	28.69	32.22	23.74	25.46	27.19	24.02
Di Wo	7.74	6.10	9.76	5.90	8.18	5.16	6.06	3.92	7.49	3.54
Di En	4.76	4.03	6.69	3.61	4.81	3.31	3.71	2.06	4.23	1.77
Di Fs	2.52	1.62	2.27	1.95	2.96	1.47	1.99	1.74	2.94	1.69
Hy En	4.97	16.20	10.76	9.93	9.44	16.79	13.57	8.02	7.30	4.26
Hy Fs	2.64	6.51	3.67	5.36	5.78	7.42	7.33	6.82	5.07	4.07
Ol Fo	5.98	−	−	1.37	−	−	−	−	−	−
Ol Fa	3.48	−	−	0.82	−	−	−	−	−	−
Mt	2.96	4.64	7.15	3.80	5.01	4.15	3.80	5.75	2.04	5.29
Il	2.78	1.66	2.07	2.90	2.78	1.92	2.04	1.48	2.28	2.05
Ap	0.59	0.44	0.50	0.57	0.37	0.43	0.67	0.87	0.27	0.57

1. Olivine basalt, lava from Kamifumi. (Loc. C)
2. Augite olivine basalt, lava from the upper stream of the Biwaushi river, 25km southwest of Rubeshibe. (Loc. K).
3. Olivine basalt, lava from Oku-shanafuchi, Engaru. (Loc. B)
4. Olivine basalt, lava from near the outcrop of No. 3, an olivine poor and plagioclase rich variety.
5. Olivine basalt, lava from south of Uehara-pass, 8km south of Konomai mine. (Loc. B)
6. Augite olivine basalt, lava from an outcrop 6km south of Onneyu (Onneyu-pass). (Loc. J)
7. Olivine basalt, lava from a quarry 1.5km west of Monbetsu. (Loc. A)
8. Nonporphyritic basalt from Asahi-pass, 10km southeast of Engaru (Yamada et al, 1963). (Loc. E)

9. Nonporphyritic basaltic andesite, 6km northeast of Saroma. (Loc. F)
10. Augite basaltic andesite, lava from the eastern margin of a lava plateau near Nissho, 2km southwest of Shotoshibetsu. (Loc. N)

Analysts: Nos. 1, 4, 5, 7, and 10 by Y. Ōba; Nos. 2, 3, 6, and 9 by N. Ikeda, No. 8 by H. Kurasawa.

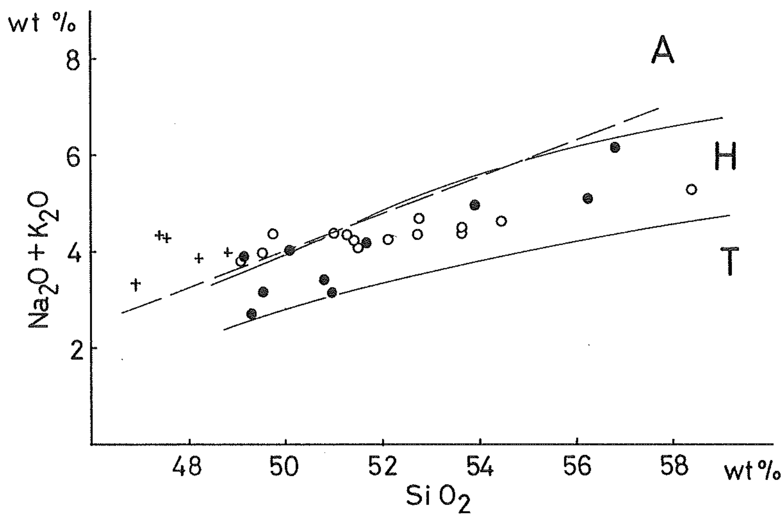

Fig. 2. Alkalis-silica diagram for the late Neogene basaltic rocks from Hokkaido. Solid circles; basaltic rocks from the Kitami-Monbetsu district. Open circles; those from the Kabato mountains (Ōba, 1968, 1971, and 1972; Ōba and Tagami, 1966). Crosses; the basin type basalts (Ōba, 1968 and 1972). Solid lines indicate the boundaries among the three rock series: A, alkali rock series; H, high alumina basalt series; and T, tholeiitic rock series (Kuno, 1965). Dashed line is the boundary between alkali rock series and tholeiitic rock series of Hawaiian lavas (Macdonald, 1968).

Kitami-Monbetsu district lie in the field of the high alumina basalt series of Japanese volcanic rocks (Kuno, 1965), and just on or near the alkali poor side of the boundary line between the alkali rock series and tholeiitic series of Hawaiian lavas (Macdonald, 1968). Transitional feature of the petrochemistry is well represented in Kuno's (1960) alumina-alkalis-silica relation diagram; the basaltic rocks from this district are chemically intermediate between tholeiitic, alkalic, and high alumina basalt types (Fig. 3).

It is noticed that the northern part of the area (Okhotsk Sea side), more alkalic olivine basalts (Nos. 1 and 4) are common, and accompany with rhyolites. While, toward the southern part, augite olivine basalt (Nos. 2 and 6) and basaltic andesite (No. 10), which are less alkalic, become predominant.

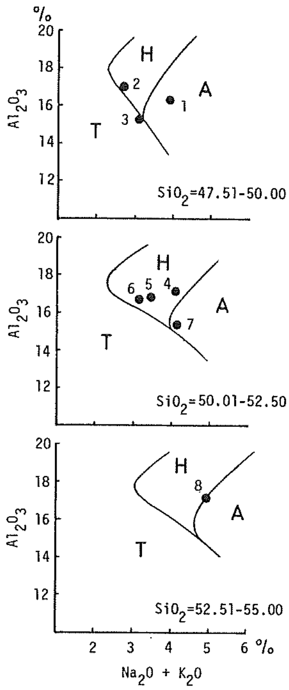

Fig. 3. Alumina – alkalis – silica relation diagram (Kuno, 1960) for the basaltic rocks from the Kitami-Monbetsu district. The numbers refer to those in Table 2. Symbols, T, H and A, are the same as those in Fig. 2.

In the western part of central Hokkaido, Ōba (1968 and 1972) called attention to the occurrence of two different types of Pliocene basaltic rocks, i.e. the basin type basalts from the Takikawa-Fukagawa basin, which are high in normative olivine and primitive (undifferentiated) alkali olivine basalts (Table 3), and the basaltic rocks from the Kabato mountains, which are nearly saturated in silica and associated with more differentiated ones. The basaltic rocks from the Kitami-Monbetsu district have a similar petrographic feature to those from the Kabato mountains (Fig. 2).

Summary

A number of small bodies of late Negogene basaltic rock occur in the Kitami-Monbetsu district, northeast Hokkaido. The basaltic rocks are composed of olivine basalt, augite olivine basalt, and basaltic andesite. Their chemical composition is similar to that of the Kuno's high alumina basalt series with respect to the alkalis-silica relation, though being not so high in alumina. The basaltic rocks have a similar petrographical feature to those from the Kabato mountains, the western part of central Hokkaido.

In the northern part of the Kitami-Monbetsu district a bimodal association of olivine basalt (more alkalic type) and rhyolite is characteristic. In the

southern part, on the contrary, basaltic rocks (less alkalic type) together with andesite are predominant. Such regional change in the nature of the late Neogene volcanic rocks may be significant with relation to the geologic structure in this district.

Table 3. Average chemical composition of the basin type basalt from Takikawa – Fukagawa basin, western part of central Hokkaido.

	wt %
SiO_2	48.2
TiO_2	1.1
Al_2O_3	17.8
Fe_2O_3	3.9
FeO	5.5
MnO	0.2
MgO	8.2
CaO	10.9
Na_2O	3.0
K_2O	1.0
P_2O_5	0.2
Total	100.0*

* Water free and avarage of 5 analyses.

Acknowledgments

The author is indebted to Professor Mitsuo Hunahashi of Hokkaido University, whose interest in the basalts of Hokkaido was influential in this study. Prof. Y. Katsui and Dr. R.H. Grapes of the same university kindly read the manuscript. I also wish to thank Miss N. Ikeda who made some of the chemical analyses reported in this paper.

References

Hasegawa, K., and Watanabe, J. (1964): Explanatory text of the geological map of Japan, 1:50,000, "Tsunemoto". Hokkaido Development Agency. (in Japanese)

Hunahashi, M. (1950): Basalts of the Uryu-Sorachi district. *Cenozoic Research (Shinseidai no Kenkyu)*, 5, 1-6. (in Japanese)

Hunahashi, M. (1953): Some ploblems of basalt. *Earth Science (Chikyu Kagaku)*, 10, 1-14. (in Japanese)

Kuno, H. (1950): Petrology of Hakone volcano and the adjacent areas, Japan. *Bull. Geol. Soc. Amer.*, 61, 957-1020.

Kuno, H. (1960): High-alumina basalt. *Jour. Petrology,* 1, 121-145.

Kuno, H. (1965): Fractionation trends of basalt magmas in lava flows. *Jour. Petrology,* 6, 302-321.

Kuroda, K., and Teraoka, Y. (1964): Explanatory text of the geological map of Japan, 1:50,000, "Saromako and Sanribanya". Hokkaido Development Agency. (in Japanese)

Macdonald, G. (1968): Composition and origin of Hawaiian lava flows. Study of Volcanology, *Geol. Soc. Amer., Memoir* 116, Howel Williams volume, 447-522.

Metal Mining Agency of Japan (1969): *Report of the fundamental geological survey of the gold mine, Konomai and Numanoue areas.* Ministry of International Trade and Industry, 22p. (in Japanese)

Nagao, S. (1968): Explanatory text of the geological map of Japan, 1:50,000, "Monbetsu". Geol. Surv. Hokkaido. (in Japanese)

Nochi, Y. et al (1967): Explanatory text of the geological map of Japan, 1:50,000, "Maruseppu". Hokkaido Development Agency. (in Japanese)

Ōba, Y. (1968): Petrological study of the Neogene basalts from the western part of Hokkaido, (1) The basin type basalts of Takikawa-Fukagawa district. *Jour. Japan. Assoc. Min. Petro. Econ. Geol.,* 60, 222-227. (in Japanese)

Ōba, Y. (1971): Petrological study of the Neogene basalts from the western part of Hokkaido, (2) Petrology of the Etai-dake basalts. *Jour. Japan. Assoc. Min. Petro. Econ. Geol.,* 66, 190-196. (in Japanese)

Ōba, Y. (1972): Petrology of the late Pliocene basalts of the western part of Hokkaido. *Jour. Fac. Sci., Hokkaido Univ.,* Ser. 4, 15, Nos. 1-2, 11-26.

Ōba, Y., and Tagami, S. (1966): Petrology of the Tertiary basalts of Hamamasu, Hokkaido, Japan. *Jour Japan. Assoc. Min. Petro. Econ. Geol.,* 56, 235-245. (in Japanese)

Sako, S., Asai, H., and Kanayama, T (1964): Explanatory text of the geological map of Japan, 1:50,000, "Kitamifuji". Hokkaido Development Agency. (in Japanese)

Satoh, H. (1961): The Etai-dake basalt complex. *Jour. Geol. Soc. Japan,* 67, 313-322. (in Japanese)

Sawamura, K., and Hata, M. (1965): Explanatory text of the geological map of Japan, 1:50,000, "Rubeshibe". Hokkaido Development Agency. (in Japanese)

Suzuki, M., and Asai, H. (1963): Explanatory text of the geological map of Japan, 1:50,000, "Shotōshibetsu". Hokkaido Development Agency. (in Japanese)

Takeuchi, K. (1942): Explanatory text of the geological map of Konomai (1:100,000). *Bull. Geol. Indust. Stat. Hokkaido,* No. 6, 1-22. (in Japanese)

Urashima, Y., Adachi, K., Hariya, Y., Ishida, Z., Omachi, H., Omura, H., Otagaki, T., and Shimizu, I. (1953): Epochs of the igneous activities and mineralization of the central part of Kitami in Hokkaido. *Bull. Geol. Comm. Hokkaido,* No. 21, 1-14. (in Japanese)

Urashima, Y., and Hariya, Y. (1954): Geology of Syanahuti table-land in Engaru Town, Hokkaido. *Jour. Min. Inst. Hokkaido,* **10**, 23-28. (in Japanese)

Yamada, K., Teraoka, T., and Ishida, M. (1963): Explanatory text of the geological map of Japan, 1:50,000, "Ikutawara". Hokkaido Development Agency. (in Japanese)

Received on Nov. 5, 1974