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Yamagata University – Rocks from
the Nanatsumori volcano, Miyagi Prefecture

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Unpublished K-Ar dates measured in the geochronology laboratory of Yamagata University – Rocks from the Nanatsumori volcano, Miyagi Prefecture

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Abstract

This report presents K-Ar dating results of volcanic rocks from the Nanatsumori volcano, Miyagi Prefecture, as measured at the geochronology laboratory of Yamagata University. K-Ar dates of lava domes in Nanatsumori Volcanic Rock were from 2.6–1.8 Ma. That of Kamikadajin Dacite was approximately 1.5 Ma. These results support the stratigraphic relation of older Nanatsumori Volcanic Rock and younger Akakuzureyama Andesite - Kamikadajin Dacite.

Introduction

The geochronology laboratory of the Yamagata University continued K-Ar dating for rocks from Quaternary volcanoes in northeastern Japan to ascertain the spatiotemporal distribution of volcanic activities in the region. These projects were undertaken earlier by former faculty members: Prof. Nobuo Takaoka, Prof. Kazuo Saito, and the late Dr. Kazuya Fukunaga, along with their graduate and undergraduate students. Measured K-Ar dates were summarized in their theses. Some have been published (e.g. Zaozan, Takaoka et al., 1989; Murayama-Hayama, Saito and Kamei, 1995; Shiratakayama, Ishii and Saito, 1997); unfortunately, many K-Ar dates have not been published.

This report presents unpublished K-Ar dates measured at Yamagata University: K-Ar dates from Nanatsumori volcano, Miyagi Prefecture. The K-Ar dating experiments for the Nanatsumori volcano samples are part of an undergraduate research project (Hashimoto, 1993MS) supervised by two former faculty members: KF and KS. Compilation and comparison of K-Ar

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dates among Hashimoto (1993MS) and other documents (Yashima, 1990; Hasenaka and Aoki, 1995; Mimura, 2001) and recalculation of K-Ar dates in Hashimoto (1993MS) were performed by one of the authors: NI. Quoted dates are valuable for overviewing the volcanic history of northeastern Japan.

K-Ar dating

Kitamura et al. (1983) summarized the geology of the Nanatsumori area. A simplified geological map of the Nanatsumori volcano is presented in Figure 1 with sampling locations used for K-Ar dating. In the Nanatsumori

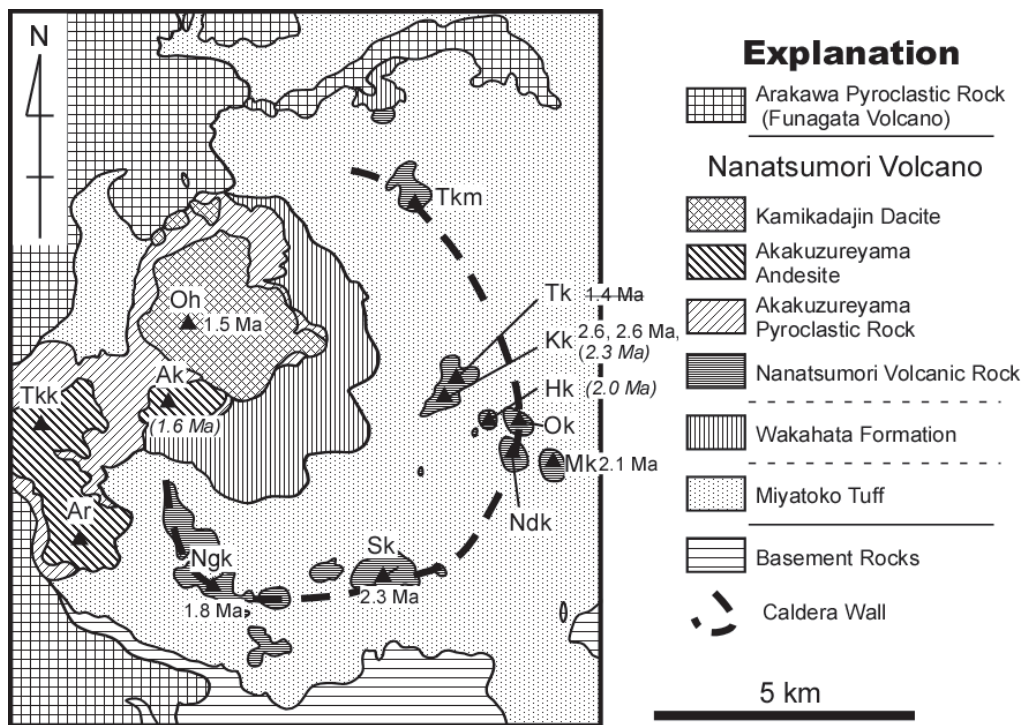


Figure 1. Simplified geological map and K-Ar dating results of the Nanatsumori volcano. The geological map is modified from that presented by Kitamura et al. (1983). Solid triangles denote summits: Tkm, Takkonmori; Tk, Togakurayama; Kk, Kamakurayama; Hk, Hachikurayama; Ok, Ohkurayama; Ndk, Nadekurayama; Mk, Matsukurayama; Sk, Sasakurayama; Ngk, Nagakurayama; Ak, Akakuzureyama; Oh, Ohatayama; Tkk, Takakurayama; and Ar, Araragiyama. K-Ar ages in parentheses were reported in earlier works. A K-Ar age of 1.4 Ma with strikethrough from Togakurayama is ignored in the discussion because of large error.

area, Nanatsumori Volcanic Rock, Akakuzureyama Andesite and Kamikadajin Dacite are distributed as volcanic facies. The Nanatsumori Volcanic Rock comprises lava domes extruded through the Nanakita Formation and the Miyatoko Tuff. The Akakuzureyama Andesite unconformably overlies the Miyatoko Tuff and Wakahata Formation. The Kamikadajin Dacite extruded contemporaneously with the Akakuzureyama Andesite. Lava domes of the Nanatsumori Volcanic Rock formed before Akakuzureyama Andesite and Kamikadajin Dacite (Kitamura et al., 1983). Earlier reported K-Ar dating results (Yashima, 1990; Hasenaka and Aoki, 1995; Mimura, 2001) support the stratigraphic relation between the Nanatsumori Volcanic Rock (2.33 ± 0.12 Ma, 2.01 ± 0.11 Ma) and the Akakuzureyama Andesite - Kamikadajin Dacite (1.59 ± 0.27 Ma). Hasenaka and Aoki (1995) designated the inner lowland of the circular distribution of lava domes and stratovolcanoes in the Nanatsumori volcano as the "Nanatsumori caldera." The lava domes of the Nanatsumori Volcanic Rock were erupted on circular fissures by post-caldera volcanism of the Nanatsumori caldera (Kitamura et al., 1983; Hasenaka and Aoki, 1995).

Six rock samples of Nanatsumori Volcanic Rock (NA-1–NA-6) and a sample of Kamikadajin Dacite (OH-1) were selected for K-Ar dating. NA-1, a hypersthene-augite dacite, was collected on the summit of Togakurayama (NA-1: N38° 26' 25", E140° 49' 50"). NA-2 and NA-3, augite-hypersthene dacite of Kamakurayama, were collected respectively on the trail (NA-2: N38° 26' 09", E140° 49' 36") and from a large outcrop (NA-3: N38° 26' 03", E140° 49' 28") of Kamakurayama. NA-4, an augite-hypersthene dacite, was collected on the trail of Matsukurayama (NA-4: N38° 25' 25", E140° 50' 59"). NA-5, a hypersthene dacite, was collected from a small outcrop near a lookout of the Sasakurayama summit (NA-5: N38° 24' 19", E140° 48' 50"). NA-6, a hornblende-bearing augite-hypersthene dacite, was collected from an outcrop on the northern flank of Nagakurayama (NA-6: N38° 24' 40", E140° 46' 15"). OH-1, an olivine-bearing and hornblende-bearing augite-hypersthene dacite, was collected from an outcrop southeast of the Ohatayama summit (OH-1: N38° 26' 39", E140° 46' 29"). The longitude and latitude are in Japan Geodetic Datum 2000 (JGD2000).

To avoid the influence of the excess argon in phenocryst, the matrix concentration was used for K-Ar dating. Fresh rock tips of a sample were crushed and sieved into a 0.15–0.30 mm size fraction. These grain samples were washed in water and dried. Phenocryst fragments were separated from the matrix fraction magnetically.

Potassium contents of samples were measured using flame photometry with an atomic absorption photometer (208; Hitachi Ltd.) in flame photometer mode. Measured potassium contents of the reference samples (JA-2, igneous rock series, Geological Survey of Japan Geochemical

Reference samples) are consistent with the reference value of JA-2 (Imai et al., 1995). The relative uncertainty of the potassium content analyses was estimated as 5%.

Abundances of radiogenic ^{40}Ar were measured using peak comparison method without ^{38}Ar spike following the procedure described by Takaoka et al. (1989). Samples were degassed at 1550°C in a Mo crucible using a resistance furnace. Extracted gases were purified by two Ti getters and were then introduced into a mass spectrometer. Argon isotopes were analyzed using a single-focus sector type of mass spectrometer with 20 cm radius and 90° deflection (Takaoka, 1976). To calculate the amount of radiogenic ^{40}Ar , corrections of mass discrimination and hot blank were conducted during the argon isotope analyses.

For K-Ar age calculation, the following constants were used: $\lambda_e = 0.581 \times 10^{-10}$, $\lambda_\beta = 4.962 \times 10^{-10}$, and $^{40}\text{K}/\text{K} = 0.0001167$ (Steiger and Jäger, 1977). Uncertainty related to the K-Ar age was calculated from the propagation of analytical errors in potassium and radiogenic ^{40}Ar contents (1 sigma level). Mass fractionation correction (e.g. Matsumoto et al., 1989; Takaoka et al., 1989; Matsumoto and Kobayashi, 1995; Ryu et al., 2013) was applied for the K-Ar dating results presented in this document. It was done using a procedure described by Matsumoto and Kobayashi (1995) with the following atmospheric argon ratios: $^{40}\text{Ar}/^{36}\text{Ar}=295.5$ and $^{38}\text{Ar}/^{36}\text{Ar}=0.187$ (Nier, 1950).

Results and Discussion

Table 1 presents results of K-Ar dating of Nanatsumori volcano. A K-Ar date of 1.40 ± 0.31 Ma for NA-1 is excluded from the following discussion because its large error attributable to the low potassium content and high air contamination ratio might reflect unrecognized weathering effects in the sample.

Yashima (1990) reported the K-Ar age of a two-pyroxene dacite sample from Hachikurayama as 2.01 ± 0.11 Ma. Hasenaka and Aoki (1995) reported a K-Ar age of 1.59 ± 0.27 Ma for the Akakuzureyama lava sample. Mimura (2001) reported the K-Ar age of an andesite sample from Kamakurayama as 2.33 ± 0.12 Ma.

For the Nanatsumori Volcanic Rock, K-Ar dates of Kamakurayama (NA-2, 2.61 ± 0.15 Ma; NA-3, 2.63 ± 0.14 Ma, 2.33 ± 0.12 Ma; Mimura, 2001), Matsukurayama (NA-4, 2.13 ± 0.11 Ma), Hachikurayama (2.01 ± 0.11 Ma; Yashima, 1990), Sasakurayama (NA-5, 2.31 ± 0.15 Ma) and Nagakurayama (NA-6, 1.80 ± 0.11 Ma) concentrate in a short period (2.6–1.8 Ma). This duration possibly represents a lava dome formation period in eastern and southern parts on the wall of the Nanatsumori caldera by post-caldera volcanism.

Table 1 K-Ar dating results of the Nanatsumori volcano

Sample No.	K (wt.%)	³⁶ Ar (10 ⁻¹⁰ cm ³ /g)	³⁸ Ar/ ³⁶ Ar	⁴⁰ Ar/ ³⁶ Ar	⁴⁰ Ar* (10 ⁻⁸ cm ³ /g)	A.C. (%)	Age (Ma)
NA-1	0.23±0.04	5.246±0.073	0.184±0.002	309.8 ± 2.0	1.25±0.27	92.3	1.40±0.31
NA-2	1.05±0.06	1.553±0.040	0.187±0.003	979.9 ± 3.8	1.06±0.30	30.2	2.61±0.15
NA-3	1.14±0.04	1.187±0.019	0.184±0.003	1191.3 ± 8.9	1.07±0.22	24.0	2.63±0.14
NA-4	1.21±0.06	1.106±0.018	0.181±0.002	1062.3 ± 6.9	8.69±0.17	26.0	2.13±0.11
NA-5	1.16±0.05	2.873±0.073	0.189±0.003	629.2 ± 2.3	9.41±0.37	48.0	2.31±0.15
NA-6	0.91±0.06	2.172±0.056	0.186±0.002	630.9 ± 3.1	7.35±0.24	46.3	1.80±0.11
OH-1	0.98±0.06	0.586±0.012	0.181±0.004	1349 ±15	6.29±0.16	20.5	1.54±0.09

N.B.

A.C. denotes the air contamination ratio (non-radiogenic ⁴⁰Ar / total ⁴⁰Ar).

Errors of dates are quoted in 1 sigma.

⁴⁰Ar* represents the radiogenic ⁴⁰Ar content.

For Akakuzureyama Andesite and Kamikadajin Dacite, a K-Ar date of Ohatayama (OH-1, 1.54 ± 0.09 Ma) of Kamikadajin Dacite and a K-Ar date of Akakuzureyama Lava (1.59 ± 0.27 Ma; Hasenaka and Aoki, 1995) show good coincidence. This result supports the inference of contemporaneous volcanic activity of the Akakuzureyama Andesite and the Kamikadajin Dacite.

K-Ar dating results of the Nanatsumori Volcanic Rock (2.6–1.8 Ma) and the Akakuzureyama Andesite - Kamikadajin Dacite (1.6–1.5 Ma), strengthen the stratigraphic relation of older Nanatsumori Volcanic Rock and younger Akakuzureyama Andesite - Kamikadajin Dacite (Kitamura et al., 1983).

Summary

K-Ar dating results reported by Hashimoto (1993MS) revealed that the volcanic activities of the Nanatsumori Volcanic Rock occurred during 2.6–1.8 Ma and that the Akakuzureyama Andesite - Kamikadajin Dacite occurred during 1.6–1.5 Ma. These results support the inference of a stratigraphic relation between older Nanatsumori Volcanic Rock and younger Akakuzureyama Andesite - Kamikadajin Dacite (Kitamura et al., 1983).

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