

新潟大学災害・復興科学研究所

共同研究報告書

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**Integrated reconstruction of the late Pleistocene
eruptive and glacial histories of Tateyama Volcano
(立山火山での噴火史と氷河史の統合的復元)**

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研究要旨 (Abstract)

A geological survey at Tateyama Volcano was undertaken to collect samples from lava flows that were emplaced during the Last Glacial Period (ca. 71-12 ka). New microanalytical data from a sample of the Tamadono lava unit reveal that the groundmass contains sanidine microlites. This feature has been shown to form due to slow cooling of relatively potassium-rich melt within lava interiors, which were insulated behind lava flow margins that cooled quickly against glaciers. The sample is suitable for high-precision $^{40}\text{Ar}/^{39}\text{Ar}$ dating, which will be undertaken in 2026 in order to clarify the timing of glacial advance at Tateyama Volcano.

A. 研究目的 (Objectives)

The aim of this project was to identify and describe eruption products that were formed by the interaction between lava flows and glaciers at Tateyama Volcano, for the scientific objectives of: (i) constraining the glacial history of Japan's Northern Alps; and (ii) advancing our understanding of the relationships between volcanic activity and glacier fluctuations. Previous studies of this area have reported landforms and deposits that were formed by the expansion of glaciers at Mount Tateyama during the last glacial period between ca. 71,000 and 12,000 years ago (Kawasumi, 2007). Volcanic activity at Tateyama also occurred during this period, and previous studies have suggested that the eruptive products may contain valuable information about the paleo-environmental conditions at that time (Ito, 1995). The characteristic textural and

morphological features of lava flows and pyroclastic units that were emplaced against glacial ice at stratovolcanoes can be recognized (Conway et al., 2015). Mapping the distributions and measuring the eruption ages of these glaciovolcanic features permits reconstruction of the previous extents of glaciers in volcanic regions (Conway et al., 2016). Application of this novel approach to paleoclimate research in Japan will offer advantages over traditional glacier reconstructions using moraine distributions that have been problematic due to poor preservation and imprecise age constraints (Sawagaki et al., 2004). By undertaking this case study at Tateyama Volcano, we aim to provide new perspectives on the links between volcanism and the cryosphere in Japan and globally, which is especially pertinent as many volcanic regions are currently undergoing deglaciation due to climate change.

B. 研究方法 (Methods)

Following preliminary field investigations at Tateyama Volcano in September 2024, Conway and Kataoka undertook a follow-up geological survey in October 2025. We constructed a plan to collect samples from several late Pleistocene lava flow units, and a sampling permit was obtained for this objective. Vent-proximal and vent-distal samples of the Tamadono lava unit were collected, to assess whether any evolution of the groundmass texture occurred during emplacement of the lava flow. Vent-distal samples were also collected from the Matsuotōge and Kunimidake lava units, but these have not yet been prepared for analysis.

Thin sections for Tamadono lava samples were prepared for microanalysis to determine the texture and composition of groundmass mineral phases. Analysis was undertaken at the Geological Survey of Japan using a JEOL JXA-iHP200F electron probe micro-analyser (EPMA). Element maps of the lava groundmass materials were collected using the wavelength dispersive spectrometers (WDS). WDS mapping was performed with 15 keV accelerating voltage, 12 nA of beam current, 1 μm beam diameter, and 50 ms dwell time.

C. 研究結果 (Results)

The field survey was conducted from October 27 to 31, 2025. Relatively heavy snowfall inhibited access to, and observation of, some of the proposed sampling targets. In particular, we were not able to assess the nature of the contact between the granodiorite basement rock and the Tamadono lava flow unit near Mount Jodo. Nevertheless, a sample (25T01) was collected from this upslope section of the Tamadono lava unit. At the downslope terminus of this lava unit, a sample (25T02) was also collected at the Tamadono Iwaya site. Here, the lava outcrop is a 20 m-high bluff with pervasive platy

joints. Both samples are porphyritic andesites with plagioclase, orthopyroxene, clinopyroxene, and hornblende phenocrysts. The groundmass of the upslope sample (25T01) appears to have a greater abundance of glass than the downslope sample (25T02), based on hand specimen observation.

Observation of EPMA back-scattered electron images was able to confirm these features of the samples. Plagioclase with oscillatory zoning is the predominant mineral phase, with subsidiary orthopyroxene and clinopyroxene. The latter two phases often exist as co-joined pairs, predominantly as euhedral to subhedral crystals without zoning, and rarely with reverse zoning or reaction rims. Hornblende crystals exhibit partial to near-complete replacement by reaction assemblages. WDS maps of the groundmass material for the upslope and downslope samples confirmed that the former has relatively greater abundances of volcanic glass. Notably, the presence of 5 μm -wide sanidine crystals was identified within the groundmass of sample 25T02 from the downslope location. Groundmass material is otherwise composed of lath-shaped plagioclase microlites and patches of tridymite (a silica polymorph), with minor orthopyroxene and magnetite.

D. 考察 (Discussion)

Based on observations made during the 2024 field survey by Conway and Kataoka, we have inferred that volcano-ice interaction occurred at Mount Tateyama during the Last Glacial Period. The key question remains: when did the glaciovolcanism occur? Samples collected during the 2025 survey provide supporting evidence for the interpretation of lava-ice interaction, and offer a way forward to clarify the timing of volcanism at this location. At present, the eruption age for the Tamadono lava flow is constrained by

unpublished radiometric K-Ar data, for which a detailed description is not available. The stated eruption ages are 38 ka and 47 ka (Nakano et al., 2010); however, uncertainties are not specified. Accounting for reasonable relative 2sd errors of around 25% for these values (i.e., 38 ± 10 ka), the true eruption age could be somewhere between 28 and 60 ka. Obtaining a precise and accurate eruption age for the lava unit is a necessary task for the objective of reconstructing the enigmatic glacial history of Tateyama Volcano. The preliminary EPMA data indicate that the sample from the Tamadono Iwaya (25T02) location is suitable for high-precision $^{40}\text{Ar}/^{39}\text{Ar}$ dating. A recent study has shown that the presence of sanidine microlites (and absence of glass) in the groundmass of andesitic lavas is beneficial for reliable argon isotopic measurements and age determinations (Conway et al., 2026). Conway will proceed with $^{40}\text{Ar}/^{39}\text{Ar}$ age analysis this year at the Geological Survey of Japan. Samples from the Matsutōge and Kunimidake lava units will also be analysed, in order to constrain the earlier growth history of the volcano.

In addition to providing a novel finding on the timing and nature of lava-ice interaction in Japan, we hope that the forthcoming results from this project will shed new light on the eruptive history of Tateyama Volcano. Furthermore, we will strive to make these research results readily accessible to the public and tourists who visit Tateyama. The motivation for this is to raise awareness of the current volcanic hazards. Although warning signs about volcanic gas hazards are posted around the walking routes, there is a lack of information regarding the response to a potential explosive (phreatic) eruption scenario from Jigokudani craters at Tateyama Volcano. As shown by recent disasters

involving volcano tourism in Japan (Mount Ontake, 2014) and New Zealand (White Island, 2019), it is critical to comprehensively convey the risks of visiting landmarks with active magmatic systems and prepare effective hazard mitigation measures. By improving the understanding of the long-term evolution of Tateyama Volcano, and highlighting that the magma system remains active at present, we hope to promote urgency for developing eruption mitigation strategies at this location.

E. 結論 (Conclusions)

This research project has built on a 2024 field investigation of the morphology and fracture characteristics of late Pleistocene lava flows at Tateyama Volcano. The 2025 geological survey successfully achieved the core objective of collecting samples from the Tamadono lava flow unit for petrological and geochronological analyses. New EPMA data has confirmed that the sample collected from the Tamadono Iwaya outcrop is suitable for high-precision $^{40}\text{Ar}/^{39}\text{Ar}$ dating, which will be undertaken by Conway in 2026.

Acknowledgments: Permits from Ministry of Environment and Chubu Regional Forest Office were issued for the investigation and sampling in the national park area at Tateyama (環中中国許第 2510242 号).

F. 研究発表 (Outcomes)

1. 論文発表 (掲載誌名・巻号・頁・発行年を記入し, 掲載論文あるいはPDFファイルを別紙で1部提出)
n/a

2. 学会発表 (学会名・発表年月・開催地なども記入)

Volcanological Society of Japan Annual Conference, 1 October 2025, Matsumoto, Nagano (“安山岩溶岩流の年代測定法の概要”)

G. 知的財産権の出願・登録状況 (予定を含む) (Patent right)

1. 特許取得

n/a

2. 実用新案登録

n/a

3. その他

n/a