

STRATIGRAPHIC AND ELECTRON MICROPROBE DATA FOR HOLOCENE TEPHRA FROM MAKUSHIN VOLCANO, ALASKA, AND FOR INTERBEDDED TEPHRA FROM OTHER VOLCANOES LOCATED AMONG OR NEAR THE ISLANDS OF THE EASTERN ALEUTIANS

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Hatfield

Raw Data File 2026-12



View of Dutch Harbor, July 2015. At least three Holocene eruptions of Makushin volcano have deposited up to 20 centimeters of ash across the Dutch Harbor/Unalaska area. (<https://avo.alaska.edu/image/view/79901>).

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STRATIGRAPHIC AND ELECTRON MICROPROBE DATA FOR HOLOCENE TEPHRA FROM MAKUSHIN VOLCANO, ALASKA, AND FOR INTERBEDDED TEPHRA FROM OTHER VOLCANOES LOCATED AMONG OR NEAR THE ISLANDS OF THE EASTERN ALEUTIANS

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INTRODUCTION

This report summarizes tephrostratigraphy and electron probe microanalytical (EPMA) data from Makushin Volcano and regional tephra in the Unalaska Island area. The data were collected by scientists from the Alaska Volcano Observatory (AVO) and the Cascades Volcano Observatory during fieldwork from 2011 to 2024. Additional EPMA analyses from this time interval are reported in Larsen and others (2020).

Makushin Volcano is part of the Makushin Volcanic Field (McConnell and others, 1998) in the north central part of Unalaska Island, Alaska, approximately 1,290 km southwest of Anchorage and 20 km west of the City of Unalaska and the Port of Dutch Harbor (fig. 1). Makushin erupted explosively to produce two large-volume, explosive Holocene deposits with ages of 9,040 (Makushin Valley) and 7,900 (Driftwood) cal. yr B.P. (Bean, 1999; Waythomas, 1999). Since then, Makushin Volcano has erupted numerous times, though individual eruptions have been significantly less voluminous than those of the early Holocene events. The most recent eruption in 1995 (McGimsey and Neal, 1996) produced small ash plumes but left no clearly preserved deposits. Eruptions from volcanoes on neighboring islands also deposited significant tephra fall on Unalaska Island. Tephra from the Okmok II caldera-forming eruption about 2050 years ago (Larsen and others, 2023) is 1-2 cm thick and drapes the area near Dutch Harbor and the City of Unalaska. Tephra from two large explosive eruptions of the Akutan volcano also covered the area 1,600 and 8,700 years ago (Waythomas, 1999). Tephra from the older Akutan eruption is up to 40 cm thick in the City of Unalaska. An additional, older silicic tephra sample originated from a distant volcano, but its provenance remains undetermined.

Data in this report are included in the public Geologic Database of Information on Volcanoes in Alaska (GeoDIVA; Cameron and others, 2022, <http://doi.org/10.14509/geodiva>). The data are also included in the accompanying tables. These data are published as a Raw Data File under an open end-user license and are available on the DGGs website (<http://doi.org/10.14509/xxxx>)

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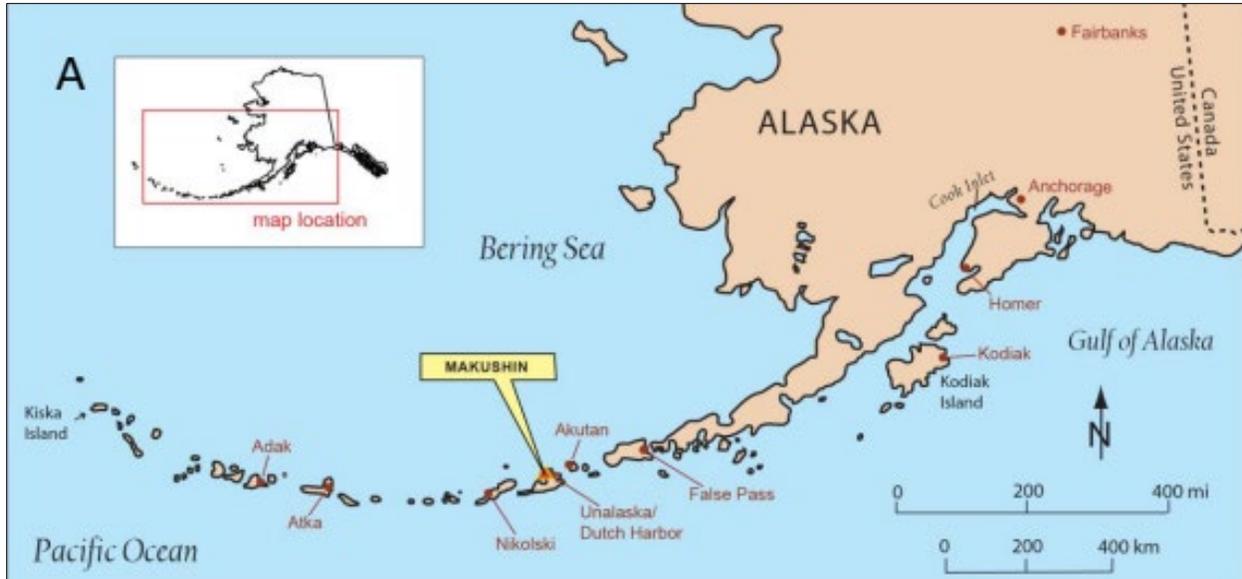


Figure 1. Location of Makushin Volcano, which lies in the north-central part of Unalaska Island, about 1,290 km southwest of Anchorage and 20 km west of the City of Unalaska and the Port of Dutch Harbor.

DATA PRODUCTS

Data and accompanying data dictionary tables included in the release provide the following information.

- **Makushin-Stations:** Stratigraphic section and sample station ID numbers, coordinates, and location descriptions, as shown in accompanying figure 1.
- **Makushin-Samples:** Sample ID numbers and their respective Station ID, source volcano, sample type, and description
- **Makushin-Layers:** Table of stratigraphic section layer data from each project year.
- **Makushin-EPMA:** Single-point electron microprobe analyses with sample ID, analytical session date, MethodID, analytical group, point number, and different glass populations for a subset of the samples. Oxide weight percentages are normalized to 100%, with the original totals provided.
- **Makushin-Analytical-Conditions:** Analytical conditions, method ID number, calibration standards, detector, crystal, and count times for each analytical session. The sessions are grouped by analytical session date and assigned a unique MethodID for correlation with the single-point data in the Makushin-EPMA table.
- **Makushin-Standards:** Working standard data in single analytical point format, including StandardID number, oxide weight percents, unnormalized, original totals, the analytical group number, and point number for each analytical spot.

METHODS

Sample Collection

AVO geologists collected samples and recorded observations from 109 stratigraphic sections during fieldwork conducted between 2011 and 2024 (fig. 2). Stratigraphic sections were

described and recorded in field notebooks during the 2011–2018 seasons. During 2023 and 2024, the sections were described both in field notebooks and digitally using the StraboSpot iPad software (strabospot.org). Location data were collected with handheld GPS devices and recorded in field notebooks. Station locations are provided using the NAD83 datum.

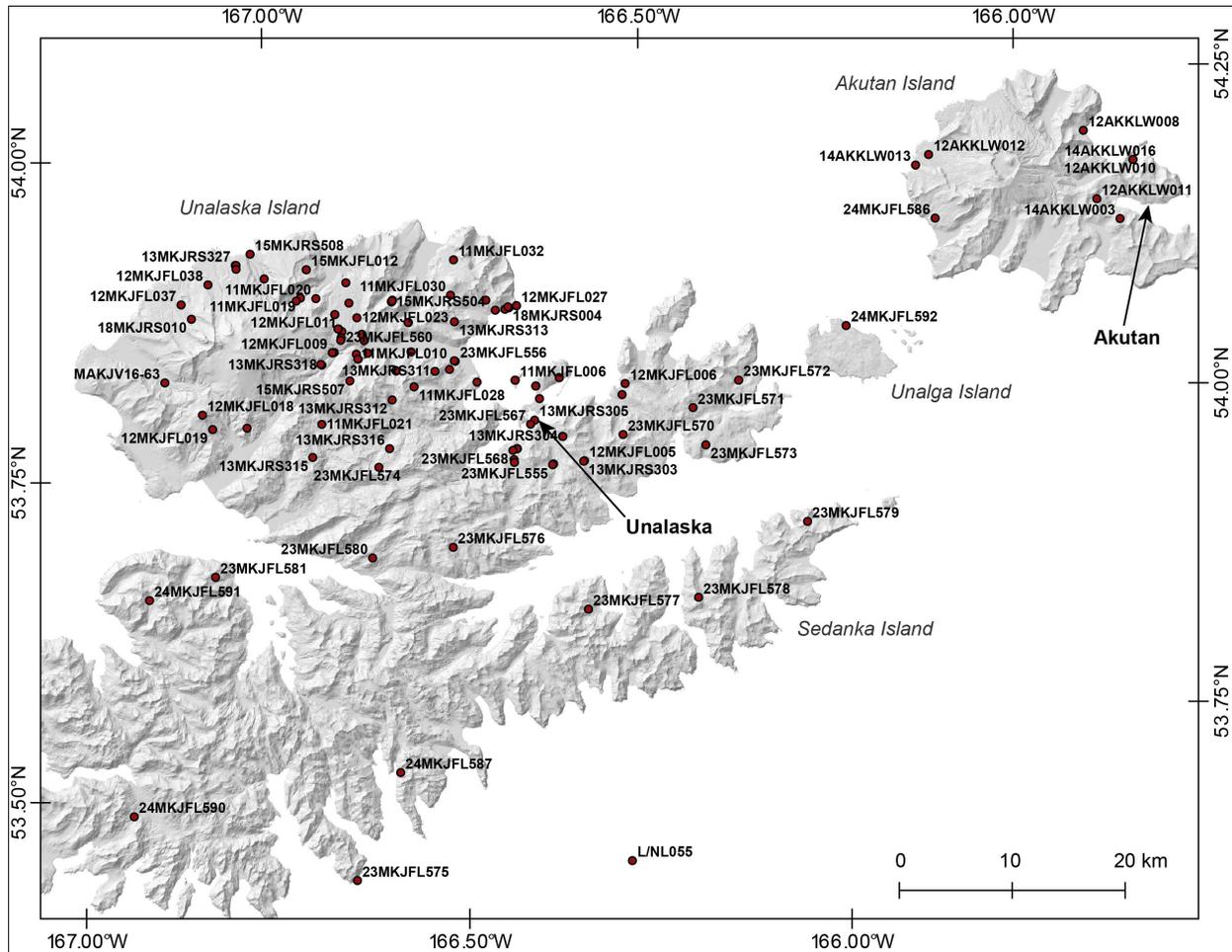


Figure 2. Location of the 109 stratigraphic sections included in this report.

Analysis

This report contains EPMA data from 126 tephra samples. The tephra samples were collected in the field and processed at the U.S. Geological Survey Alaska Tephra Laboratory (USGS ATL) in Anchorage, Alaska. The bulk samples were sonicated in tap water for 10 to 30 minutes, then wet-sieved and separated into size fractions: >250 μm , 125–250 μm , and 63–125 μm . Fractions less than 63 μm were discarded. Sieved tephra were dried for 12 to 24 hours at 40 °C in a drying oven and then examined under a binocular microscope to determine the size fraction with the highest glass content. For most samples, the modal size fraction was used as representative, and grain mounts were prepared from that material.

Polished grain mounts were prepared using one-inch-round epoxy pucks and glass slides at the USGS ATL and the University of Alaska Fairbanks (UAF), following the method of Loewen and others (2023). Analyses were conducted using the UAF Advanced Instrumentation Laboratory JEOL JXA-8530F electron microprobe with the AVO tephra analytical routine (Loewen and others, 2023). The analytical beam was set to 15 keV and 5 to 10 nA, with a 5 μm beam size to minimize Na, Al, and Si migration effects caused by beam interaction with glass. Na was analyzed first for each data point (Nielsen and Sigurdsson, 1981), and a time-dependent intensity correction was applied to correct for reduced Na counts using the Probe for EPMA software package (©John Donovan, Probe Software, Inc.). Calibration standards used for each element from each session are: Na – TALBITE or Albite 4; Mg – Diopside (USNM 117733); Al – TALBITE; Rhyolitic Glass (USNM 72854 VG-568) Basaltic Glass (BG1, USNM 111240/52 VG-2) or Basaltic Glass (BG-3, USNM 113716); Si – TALBITE; Rhyolitic Glass (USNM 72854 VG-568) Basaltic Glass (BG1, USNM 111240/52 VG-2) or Basaltic Glass (BG-3, USNM 113716) K – OR10 CT; Ca – Wollastonite; Ti – Rutile; P – Apatite; Cl – Scapolite (USNM R6600-1); Fe- Fayalite (USNM 85276); Mn – Spessartine (SPGA). Calibration and working standard data for each analytical session are included in a separate table. Working standards, analyzed before, during, and after each analytical session, consisted of the following: Rhyolitic Glass, USNM 72854 VG-568; CCNM; Basaltic Glass (BG-2), USNM 113498/1 VG-A99; and Basaltic Glass (BG-3), USNM 113716. See Loewen and others (2023) for an in-depth discussion of the analytical uncertainties.

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REFERENCES

- Bean, K.W., 1999, The Holocene eruptive history of Makushin Volcano, Alaska: University of Alaska Fairbanks, unpub. M.S. thesis, 130 p.
- Cameron, C.E., Crass, S.W., and AVO Staff, eds., 2022, Geologic Database of Information on Volcanoes in Alaska (GeoDIVA): Alaska Division of Geological & Geophysical Surveys Digital Data Series 20, <https://doi.org/10.14509/geodiva>
- Larsen, J.F., Neal, C.A., Schaefer, J.R., and Nye, C.J., 2023, Geologic map of Okmok Volcano, Alaska: Alaska Division of Geological & Geophysical Surveys Report of Investigation 2023-1, 63 p., 4 sheets, <https://doi.org/10.14509/31015>

- Larsen, J.F., Schaefer, J.R., Vallance, J.W., and Neill, O.K., 2020, Petrology and geochemistry of three Early Holocene eruptions from Makushin Volcano, Alaska: *Bulletin of Volcanology*, v. 82, no. 72, 17 p., <https://doi.org/10.1007/s00445-020-01412-5>
- Loewen, M.W., Wallace, K.L., Lubbers, Jordan, Ruth, Dawn, Izbekov, P.E., Larsen, J.F., and Graham, Nathan, 2023, Glass electron microprobe analyses methods, precision and accuracy for tephra studies in Alaska: Alaska Division of Geological & Geophysical Surveys Miscellaneous Publication 174, 20 p., <https://doi.org/10.14509/31045>
- McConnell, V.S., Beget, J.E., Roach, A.L., Bean, K.W., and Nye, C.J., 1998, Geologic map of the Makushin volcanic field, Unalaska Island, Alaska: Alaska Division of Geological & Geophysical Surveys Report of Investigation 97-20, 2 sheets, scale 1:63,360, <https://doi.org/10.14509/2576>
- McGimsey, R.G., and Neal, Christina, 1996, 1995 volcanic activity in Alaska and Kamchatka—Summary of events and response of the Alaska Volcano Observatory: U.S. Geological Survey Open-File Report 96-0738, 22 p.
- Nielsen, C.H., and Sigurdsson, H., 1981, Quantitative methods for electron microprobe analysis of sodium in natural and synthetic glasses: *American Mineralogist*, v. 66, no. 5–6, p. 547–552.
- Waythomas, C.F., 1999, Stratigraphic framework of Holocene volcanoclastic deposits, Akutan Volcano, east-central Aleutian Islands, Alaska: *Bulletin of Volcanology*, v. 61, no. 3, p. 141–161, <https://doi.org/10.1007/s004450050268>