Digitizing Alaska's ashfall record: a tephra geospatial database

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Janet Schaefer[1], **Katherine M. Mulliken[1]**, Cheryl Cameron[1], Kristi Wallace[2]

[1]Alaska Division of Geological & Geophysical Surveys, Fairbanks AK
[2]U.S. Geological Survey, Anchorage AK

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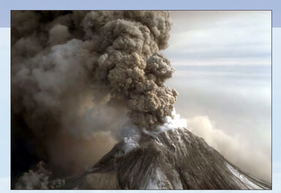
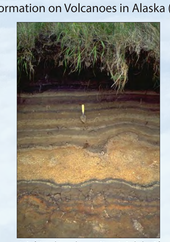
Introduction

Tephra studies are vital in understanding the frequency and magnitude of volcanic eruptions and are a key component of volcano-hazard assessments and interdisciplinary studies that rely on tephra deposits as time-stratigraphic markers. Key chronostratigraphic markers may be used to link marine, lacustrine, and terrestrial records and are important to disciplines including volcanology, tsunami and seismic hazard assessments, paleoenvironmental studies, and archaeology.

Information on tephra deposits in Alaska is distributed amongst hundreds of publications that span numerous research disciplines. In order to streamline tephra occurrence data, these disparate publications have been compiled into one comprehensive geospatial dataset within the Alaska Tephra Database module of the Alaska Volcano Observatory's (AVO) Geologic Database of Information on Volcanoes in Alaska (GeoDIVA).



[1]Eruption column rising over Augustine Volcano, March 27, 1986.



[2]Terrestrial tephra deposits at Adak, Alaska.

[3]Tephra deposits in a lacustrine core, Alaska.

Project Purpose

- Compile geospatial information on tephra deposits in Alaska, integrate with station/sample information in GeoDIVA (AVO Geologic Database of Information on Volcanoes in Alaska) Alaska Tephra Database.
  - Geospatial information compiled includes:
    - Dispersion area
    - Locations of occurrence and deposit thickness
    - Contours (thickness, maximum particle size, mass-per-unit area)
  - Other information compiled includes:
    - Deposit/eruption age, possible source volcano
    - References

Process

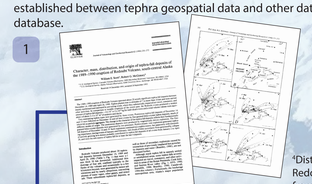
1) Review of over 600 references for geospatial information on tephra deposits.

2) Original figures captured and georeferenced in ArcGIS.
   - Approximately 225 figures, from 105 references, were identified with distributional information.

3) Data from figures digitized in ArcGIS and associated metadata entered.
   - Approximately 700 contour lines digitized as polylines.

4) Tephra deposit footprints created as polygons using published contours.

5) GeoDIVA station/sample information exported and data relationships established between tephra geospatial data and other data already in the database.



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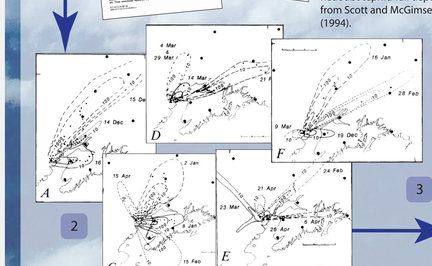

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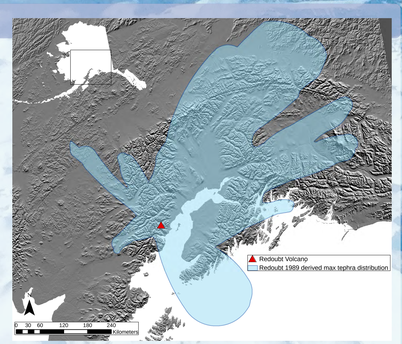

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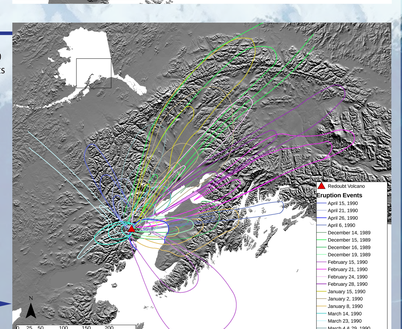
[4]Distribution of the 1989-90 Redoubt tephra-fall deposits from Scott and McGimsey (1994).



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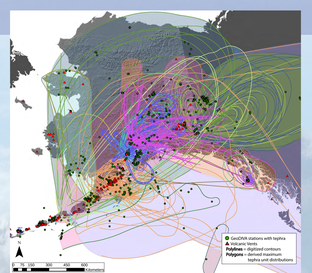
What's in the Database?

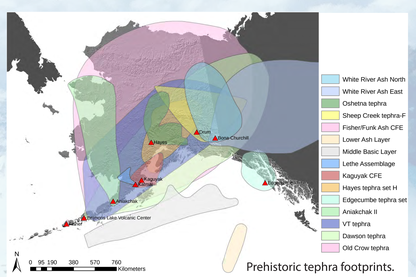
- **Polylines and polygons (tephra footprints) associated with ~40 eruptions from ~20 volcanoes in Alaska:** Aniakchak, Augustine, Mt Churchill, Crater Peak (Spurr), Drum, Edgecumbe, Emmons Lake Volcanic Center, Fisher, Hayes, Kaguyak, Katmai, Mageik, Makushin, Novarupta, Okmok, Pavlof, Redoubt, Shishaldin, Ukinrek Maar, and unknown sources.

- **Attribute fields include:** tephra name, sub unit, isopach contour (cm), isomass contour (cm), isopleth contour (g/m^2), map label, possible source volcano, reference, original figure number and scale, age epoch, age in reference, best age, best age reference, age notes, proximal description (and reference), distal description (and reference).

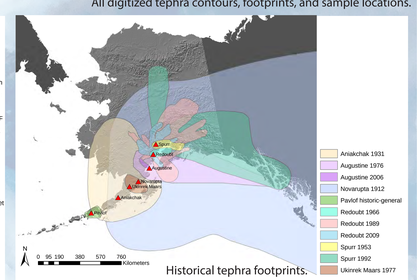
- **Published station and sample information extracted from GeoDIVA includes** ~1600 station locations (all with tephra samples) and a total of ~4500 tephra samples. Station and sample information includes station/sample name, coordinates, geologist, date visited, station description, sample description, tephra name, possible source volcano, sample type, age information, color, comments, and references.



All digitized tephra contours, footprints, and sample locations.



Prehistoric tephra footprints.



Historical tephra footprints.

Dataset Examples

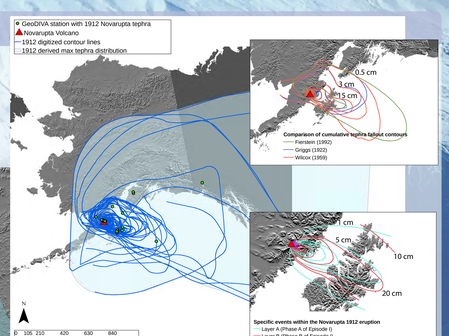
Volcano-Specific, Aniakchak:

View stations with tephra samples erupted from Aniakchak volcano.

View tephra contours and footprints associated with eruptions:
Aniakchak 1931
Aniakchak II CFE, ~3500 cal. yr B.P.

[5]Aniakchak caldera.

[6]1931 Aniakchak tephra deposits.



Eruption-Specific, Novarupta 1912:

Compare tephra thickness contours from different publications (A).

View stations with tephra samples from the 1912 Novarupta eruption.

View tephra contours associated with specific eruptive events (B):
Layers A, B, C, D, E, F, G, H

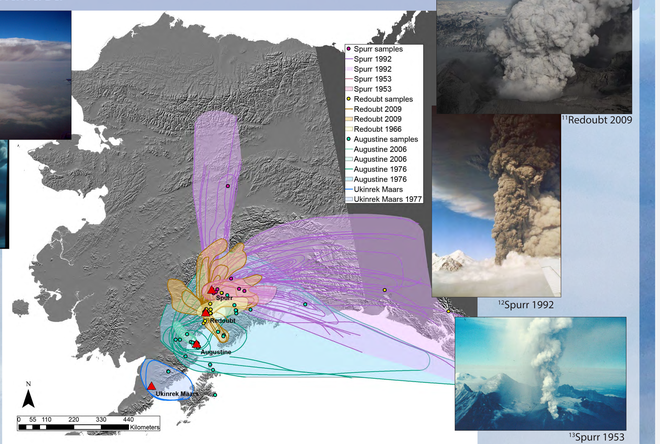
[7]1912 airfall deposits.

Dataset Examples Continued

[8]Augustine 2006

[9]Augustine 1976

[10]Ukinrek Maars 1977



[11]Redoubt 2009

[12]Spurr 1992

[13]Spurr 1953

Data Dissemination

This database will be published as a digital dataset through the Alaska Division of Geological & Geophysical Surveys within the next year. We hope it will be a valuable resource to researchers in various fields, and we encourage and appreciate feedback and comments!

The Alaska Tephra Database, which includes published Alaska tephra station and sample information, as well as age and geochemical data if available, will also be published soon through the Alaska Division of Geological & Geophysical Surveys.

Other relevant datasets include:

Cameron, C.E., and Schaefer, J.R., 2016, Historically active volcanoes of Alaska: Alaska Division of Geological & Geophysical Surveys Digital Data Series 6, http://doi.org/10.14509/historically_active_volcanoes. http://doi.org/10.14509/27061

Schaefer, J.R., and Wallace, K.L., 2012, Ash fall countour map of the 2009 eruption of Redoubt Volcano, Alaska: Digital shapefiles of contours and sample locations: Alaska Division of Geological & Geophysical Surveys Miscellaneous Publication 143, 1 DVD. http://doi.org/10.14509/23463

Data Dilemmas

- Geospatial accuracy issues arise when digitizing contours and sample locations from very small, non-georeferenced illustrations and map figures.

- Ash fall contour lines of the same deposits sometimes appear in numerous publications and vary slightly in each report (original reference digitized).

- Software challenges were encountered when creating dynamic links to GeoDIVA tables from within ArcGIS.

- Geochronologic information is reported in a variety of formats, including age ranges, making it difficult to design data input rules that are query friendly.

Find the Alaska Volcano Observatory online

Alaska Volcano Observatory website: avo.alaska.edu
Current information on Alaska volcano eruptions, real-time monitoring data (webcams, seismic and RSAM data), information on volcanoes in Alaska, reference and image search.

Follow the Alaska Volcano Observatory on Social Media

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Comments/Questions? katherine.mulliken@alaska.gov, janet.schaefer@alaska.gov

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This poster has not undergone technical peer review and should not be used or cited as reviewed. Future reviewed publications may or may not change what is presented here.

References

Background image: Caporn, R., "Pavlof volcano in eruption, March 27, 2016." Alaska Volcano Observatory, id=94371, https://www.avo.alaska.edu/images/image.php?id=2.
[1]U.S. Geological Survey, "A vigorous eruption column rising over the summit of 1,282-m (4,206 ft)-high Augustine Volcano." Alaska Volcano Observatory, id=397, https://www.avo.alaska.edu/images/image.php?id=28.
[2]Neal, C.A., "Adak Tephras." Alaska Volcano Observatory, id=13648, https://www.avo.alaska.edu/images/image.php?id=19.
[3]Wallace, K.L., "Short core recovered from Bear Lake, 35 km east of Redoubt Volcano." Alaska Volcano Observatory, id=3220, https://www.avo.alaska.edu/images/image.php?id=50.
[4]Scott, W.E., and McGimsey, R.G., 1994, Character, mass, distribution, and origin of tephra-fall deposits of the 1989-1990 eruption of Redoubt volcano, south-central Alaska: in Miller, T.P. and Chouet, B.A. (eds.), The 1989-1990 eruptions of Redoubt Volcano, Alaska, Journal of Volcanology and Geothermal Research, v. 62, n. 1, p. 251-272.
[5]Williams, M., "Aerial view, looking east, of Aniakchak caldera, one of the most spectacular volcanoes on the Alaska Peninsula." Alaska Volcano Observatory, id=40842, https://www.avo.alaska.edu/images/image.php?id=40842.
[6]Neal, C. A., "1931 tephra on caldera floor, Aniakchak caldera." Alaska Volcano Observatory, id=10408, https://www.avo.alaska.edu/images/image.php?id=10408.
[7]Figure 15 in Hildreth, W., and Fierstein, J., 2012, The Novarupta-Katmai eruption of 1912: Largest eruption of the twentieth century: Centennial perspectives: U.S. Geological Survey Professional Paper 1791, 259 p.
[8]McGimsey, R. G., "Steam plume with minor ash extending northeastward from Augustine volcano." Alaska Volcano Observatory, id=7295, https://www.avo.alaska.edu/images/image.php?id=7295.
[9]Kienle, J., "Augustine volcano in eruption, 1976." Alaska Volcano Observatory, id=9646, https://www.avo.alaska.edu/images/image.php?id=9646.
[10]Kienle, J., "Aerial view of a phreatomagmatic eruption of the East Maar of Ukinrek Maars." Alaska Volcano Observatory, id=3781, https://www.avo.alaska.edu/images/image.php?id=3781.
[11]Waythomas, C. F., "Redoubt volcano and eruption plume on March 31, 2009." Alaska Volcano Observatory, id=17643, https://www.avo.alaska.edu/images/image.php?id=17643.
[12]McGimsey, R. G., "Rolling eruption column rising from Crater Peak vent of Mt. Spurr volcano." Alaska Volcano Observatory, id=10787, https://www.avo.alaska.edu/images/image.php?id=10787.
[13]Co-Op Photo Shop, "Aerial photograph of Crater Peak's (Mt. Spurr) 1953 eruption." Alaska Volcano Observatory, id=44011, https://www.avo.alaska.edu/images/image.php?id=44011.