Tephra 2014
Maximizing the potential of tephra for multidisciplinary science

Tephra 2014: Summary and Consensus Document

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Tephra 2014

Introduction

Meeting Overview

The Tephra 2014 Workshop was convened 3-7 August, 2014, to discuss major developments, best practices, and future directions/needs in tephra studies from both volcanological and tephrochronological perspectives. By bringing together an international group of over 70 scientists with a variety of backgrounds who study tephra for different purposes, the hope was to enhance interdisciplinary collaboration and data sharing. To provide training, the workshop also incorporated hands-on sessions on optimal sample collection and treatment, dispersal modeling, and the use of databases. Volcanologists, tephrochronologists, archaeologists, paleoclimatologists, paleoecologists, paleolimnologists, petrologists, geochronologists, tectonophysicists, Quaternary scientists, atmospheric scientists, data managers, and others who work with tephra were represented.

During a day-long field trip on Day 1, and three days of presentation and discussion, tephra scientists discussed challenges, opportunities and solutions in studies ranging from physical volcanology to archeology. A consensus-seeking session was held at the end of the meeting, in which the current state of the science and emergent issues were raised. Most of the discussion in the session revolved around formulating common best practices among the different scientific communities and establishing common data archiving and retrieval mechanisms. Best practices were discussed in terms of sample collection and laboratory treatment. It was felt that a starting point for ensuring some uniformity in collection and laboratory work was to develop data sheets or templates, in addition to a consensus document. The data sheets would be constructed in such a way to allow scientists who might not be expert in one field to nevertheless collect and analyze data that would be of importance to scientists in another field. With respect to data archiving and retrieval, the discussion revolved in large part around databases, what is currently available, their use, and development of common standards for submission and data format.

Detailed Description

The meeting started on Day 1 with a field trip to Mount St. Helens on Monday, 3 August. This included two main tephra stops focusing on the major tephra-producing eruptions of the last ~16 kyr. Stop 1, Stratigraphy Viewpoint, has excellent exposures created by floods and lahars that swept down the Muddy River on May 18, 1980. The stratigraphy includes multiple layers of tephra-fall, flow and surge, and lahars. Tephra sets S, J, Y, P, B, W, and X are represented. Lunch was consumed at Bear Meadows viewpoint near the location where Gary Rosenquist took his famous photographs of the initiation of the 1980 landslide and eruption. Stop 2 provided exposures of tephra deposits including 1980, layer T, set X, layer Wn, set B, set P, layer Yn, and set J. During the field trip, excellent discussions were had about the characteristics of proximal deposits and about tephra sampling and documentation. The field trip also got participants better acquainted with one-another, encouraged lively discussion, and set the stage for the next three days of the workshop.

Day 2 of the workshop opened with plenary talks by two of tephrochronology's great pioneers, John Westgate and Andrei Sarna-Wojcicki, who were together for the first time in many years. John spoke about "Tephra from creation to deposition" giving an overview of the processes which result in tephra deposits, as well as outlining synergies between tephrochronology, volcanology, and petrology. Andrei in his talk on "Development and application of tephra studies" provided a history, including people, methods, and major discoveries.

Subsequent talks emphasized the need for common terminologies to aid collaboration and communication, and the types of field data that all scientists working with tephra should collect and report. Other highlights include: advances in Antarctic tephrochronology; advances in Ar-dating of tephras; advances and best practices in tephra geochemistry (major, trace and isotope geochemistry); the discovery that the 860BP cryptotephra in Europe originates from the White River eruption in Alaska, thus establishing the potential for trans- Atlantic isochrons; and a note that lakes fed by large catchments may record eruptions even without receiving direct tephra fall. Gill Plunkett noted that the rapid expansion of cryptotephra studies has raised an important question: How many shards does it take for a cryptotephra to be an isochron?

Day 3 began with discussion of tephrostratigraphy and dating methods. This included talks on the extensive tephra record at Mono Lake, dating tephras by the glass fission-track method, the combination of paleomagnetic records and tephrochronology to improve our understanding of both, and a key lacustrine record of Icelandic tephras. These were followed by several talks and discussions of volcanological aspects of tephra studies from proximal to distal. This included a novel use of ground- penetrating radar in coarse proximal deposits and ash transport modeling using Ash3D. Eruption examples ranged from maars to rhyolitic Plinian type. The day concluded with a session on methods of tephra correlation and applications of tephra isochrons. The application of statistical methods like principle component analysis (PCA) to tephra correlation was considered. Examples of long-distance correlation included refining the extent of the Younger Toba tephra, and use of the Glacier Peak tephra to define a continent-spanning isochron. Such long-distance correlations also have potential to aid studies of ash dispersal, and are a great example of the potential for volcanologists and tephrochronologists to benefit from sharing data.

The morning of Day 4 consisted of a short session on tephra databases and catalogs followed by working groups and closing discussion. Anthony Newton demonstrated several new features of Tephrabase, designed to make the database a great tool, not just a repository. These include easier data entry, data versioning, the ability to define sub-populations within individual samples, various search tools, and the automatic generation of stratigraphic columns. Kerstin Lehnert summarized tephra-relevant data types within IEDA systems, including samples, geochemistry, geochronology, petrology, and marine, as well as the development of special portals to serve different research communities. Kerstin also discussed new journals designed specifically for publishing data. Kristi Wallace described the growing Alaska Tephra Database being developed by the USGS. This houses in one system an extensive array of information including details on samples, sample preparation and processing, physical characteristics, geochemistry, and ages.

The afternoon consisted of hands-on sessions. A session on dispersal modeling provided the opportunity to work with PUFFIN and Tephra2D. During a session on tephra in sediment cores, participants were able to get up close with some tephra-bearing marine and lake cores and try taking their own samples. The third session on contributing to open databases included demonstration of multiple systems, and evolved into an extended discussion of data issues.

Break-out Working Groups

On Day 4, Thursday, 10:30—11:30, a breakout session with six working groups was convened. Members of the separate groups were chosen to ensure a mix of disciplines within each group. The organizers asked that each group consider preliminary questions that had been formulated, prioritize them, and discuss what to them are the three most important questions. In discussing the three most important questions, each group considered the challenges and opportunities represented, and possible solutions or paths forward. After this, from 11:30—12:00, we reconvened. Each group gave a brief presentation about their prioritized list, the three most important questions, and their proposed responses.

Workshop Website and Resources

At the start of the workshop organization process, a website was established on vHub, the virtual, collaborative environment for volcanological research. The home website is publicly accessible at http://vhub.org/groups/tephra2014. From the home website, there are links to the Tephra 2014 Wiki, with a version of the detailed meeting description and links to all presentations, which were videotaped, and to PDFs of posters. There are links to Tephra 2014 Resources, which include the field guide and a post-meeting synopsis, delivered as a poster presentation at the 2014 AGU Fall Meeting. Other resources include a copy of the present document, and its Appendices I, II and III. Appendix I is a checklist for tephra collection; Appendix II is a checklist for tephra analysis, and Appendix III is a checklist for tephra correlation. This report and its appendices were produced as the primary meeting outcomes, and to help serve as a 'jumping off point' for development of standard methodologies.

Consensus recommendations

Summary of Major Themes

Two main themes dealing with two of the preliminary questions were consistently emphasized by the six groups in the breakout session. Both themes focus primarily on data issues.

Major Theme 1

There is a need for standardization of tephra field/core data collection, geochemical analysis, correlation, and data reporting. Everyone should publish supplementary data. What data are published may need to be discipline specific, but starting with a skeleton common to everyone and a list of discipline-specific best practices would be helpful. Standardizing terminology (volcanic, sedimentary, etc.) would facilitate data sharing. Best practices may address, for example, sample imaging, data visualization, dating, sample preparation, physical and chemical characterization, and reporting of uncertainties. The tephra community should produce best practice fact sheets, minimum requirements, etc. (see Appendices I-III for examples). These could be distributed via list-serves, web sites (Vhub), and conferences as well as sent to journals for use by editors and reviewers.

Major Theme 2

There is a great need for databases to facilitate information access across disciplines. Standardizing (see theme 1 above) is a first step toward greater use of databases. The community may work with new or existing trusted repositories. Interoperability between databases (e.g. regional databases feeding a global database or search interface) should aid progress. Databases need to be planned for the long-term (funded with staff to maintain), and there needs to be support for the large and critical task of getting decades of existing data into openly accessible systems. The community should also call for all new data sets to be contributed to such systems.

Further Recommendations

Metadata and documentation of data quality. The best practices on data reporting should list the minimum information that must be included for tephra samples (e.g., location, collector and date, type of sample, physical description, sampling technique, photographs/images, layer thickness, particle size, stratigraphic context, archival location, etc.). Full documentation and transparency facilitate data evaluation and quantification of uncertainties, and increase the possibility of replication (e.g., recollecting samples of the same layer from the same, original location). For analytical data, full documentation includes methodology from sample collection to the final analytical results. Analytical data must be accompanied by results from recognized reference materials obtained using the same procedures.

Existing IEDA templates for samples and geochemistry could serve as a starting point.

Correlation methods and uncertainties. There remains some lack of clarity about best practices in establishing tephra correlations and evaluating the uncertainties of such correlations, especially for ultra-distal, cryptotephra deposits. One common, but not well-answered question is: What statistical techniques work best? In general, correlations supported by more information (stratigraphy, ages, geochemistry – i.e., a multi-

parameter approach) are likely to be more robust. Analytical uncertainties can be minimized by running unknown samples and potential correlatives consecutively during the same analytical session.

Meeting participants

Organization committee

Marcus Bursik, Solene Pouget (University at Buffalo), Steven Kuehn (Concord University), Kristi Wallace (USGS)

On-site organization committee

Michael Cummings, Martin Streck, Scott Burns (Portland State University)

Attendees

First name	Last name	Affiliation
Faculty and professionals		
Kenneth	Adams	Desert Research Institute
Nicholas	Pearce	Department of Geography and Earth Science, University of Aberystwyth
Victor	Baker	University of Arizona
John	Westgate	University of Toronto
Chungwan	Lim	Seoul National University
Michele	Punke	Historical Research Associates, Inc.
Susan	Zimmerman	Center for AMS, Lawrence Livermore National Lab
Andrei	Kurbatov	Climate Change Institute, University of Maine
Nelia	Dunbar	New Mexico Tech
Marie-Noelle	Guilbaud	Instituto de Geofisica, Universidad Nacional Autonoma
Anthony	Newton	University of Edinburgh
Kristi	Wallace	U.S. Geological Survey/Alaska Volcano Observatory
Kerstin	Lehnert	Columbia University
Richard	Streeter	University of St Andrews
Jim	Gardner	Jackson School of Geosciences, The University of Texas
Joseph	Stoner	CEOAS Oregon State University
Eva	Hulse	Archaeological Investigations Northwest
Chris	Campisano	Institute of Human Origins / Arizona State University
Nancy	Van Wagoner	Thompson Rivers University
Andrei	Sarna-Wojcicki	U.S. Geological Survey (Emeritus Volunteer)
Miriam	Jones	U.S. Geological Survey
Gill	Plunkett	Queen's University Belfast
William	McIntosh	NM Bureau of Geology & Mineral Resources
Post-doctoral researchers		
Emma	Gatti	University of Cambridge, JPL

Leah	Courtland	Georgia Tech
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Thomas	Roland	University of Exeter
Sebastien	Bertrand	Ghent University
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