

Major Element and Trace Element Compositions of Tephra Layers Found in European Varved Lake Records

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Anna Beckett¹, Cécile Blanchet², Alexander Brauser², Rebecca Kierney², Celia Martin-Puertas¹, Ian P. Matthews¹, Konstantin Mittelbach², Adrian Palmer¹, Arne Ramisch², Achim Brauer²

1. Royal Holloway University, London, UK
2. GFZ German Research Centre for Geosciences, Potsdam, Germany

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4. Data Description

This database contains major and trace element compositions of European tephra and metadata for the datasets and lakes they were found in. A total of 49 individual tephra layers across varved lake records have been included, with Lago di Grande Monticchio being the largest contributor of geochemical data with 28 layers. The Vedde Ash and Laacher See tephra are the most common layers, being found in 6 different varved records, and highlight the potential of refining the absolute age estimates for these tephra layers using varve chronologies and for synchronising regional paleoclimate archives.

This project is the first stage in a 5-years plan funded by the Past Global Changes (PAGES) Data Stewardship Scholarship to incorporate a global dataset of tephra geochemical data in varved sediment records. Further stages of this project will focus on different regions and timescales.

This data is part of the Varved Sediment Database (VARDA, <https://varve.gfz-potsdam.de>; Ramisch et al., 2019, 2020).

4.1. Sampling method

The data was collected from scientific literature and crosschecked for data redundancy with the RESET database and PANGAEA database. Contextual metadata, such as information about the location, the sediment core, instrument parameters at measurement, and references, were collected from the primary literature. For missing lake metadata, secondary literature was included where possible.

4.2. Analytical procedure

The analytical procedure emphasizes the description of analytical conditions, such as instrument configuration (i.e. beam diameter, beam current, beam accelerating voltage), and standards used for calibration to improve the reusability of the published data, where valuable information is often siloed in the article texts or appendices.

4.3. Data processing

Data processing involved defining objects, such as lakes, datasets, and datapoints (the actual measurements) and adding primary and foreign keys so that each datapoint can be referenced to both, the corresponding lake and/or dataset, depending on the use case requirements. Furthermore, datasets and datapoints are labeled by specific attributes, such as data availability, analytical method, correlation (to a volcanic event), source volcano, and more to provide filtering options when re-using this data.

5. File description

5.1. File inventory

The file named "2023-XXX_becket-et-al_tephra-chemistry.xlsx" contains information about all objects in the database, including lakes, datasets, and geochemical measurements. The data is organized into three hierarchical levels. The top-level objects, or parents (in this case, lakes), contain children (i.e., datasets) which in turn contain datapoints of element composition measurements. The metadata for each object is stored in its respective worksheet, and can be referenced to other tables via foreign keys (i.e. "lake" and "dataset"). Information about lakes can be found in the "Lakes" worksheet, datasets in the "Datasets-Metadata" worksheet, and geochemical measurements in the "Tephra_Major_Elements" and "Tephra_Trace_Elements" worksheets. CSV exports of the worksheets are located in the directory "data_csv". The CSV files are pipe delimited.

5.2. Description of data tables

5.2.1. Table 1: Lakes

Column header	Unit	Description
lake	-	Name of the lake (current or past) from which the sediment core was taken.
latitude	DD.dddd	Latitude of the location where the sample was collected. Entered in decimal degrees. Negative values for South latitudes. (Coordinate system: WGS84)
longitude	DD.dddd	Longitude of the location where the sample was collected. Entered in decimal degrees. Negative values for West latitudes. (Coordinate system: WGS84)
country	-	ISO 3166 (alpha-2) code of the country (or countries) the lake is located in.
surface_area	m ²	Area of the water body surface in square metres.
maximum_depth	m	Deepest point of the water body (if applicable).
volume	m ³	Volume of the lake's water body in cubic metres.
catchment_area	m ²	Area of the water body's catchment in square metres.
surface_level	-	Elevation of the water surface.
surface_level_unit	-	Unit for the numerical value provided for 'Surface Level' (e.g. 'm a.s.l.' or 'm NN').
secondary_data_source_1	-	Source in apa (en-GB) citation style (https://citation.crosscite.org/) for metadata marked with one star symbol (*)
secondary_data_source_doi_1	-	Source DOI (Digital Object Identifier, https://doi.org/) for metadata marked with one star symbol (*)
secondary_data_source_2	-	Source in apa (en-GB) citation style (https://citation.crosscite.org/) for metadata marked with two-star symbols (**)
secondary_data_source_doi_2	-	Source DOI (Digital Object Identifier, https://doi.org/) for metadata marked with two-star symbol (**)
comments	-	Comments can be added to provide special remarks about the lake that are not represented by other columns.

Table 1 Field names for the table "Lakes"

4.3.2 Table 2: Datasets

Column header	Unit	Description
dataset	-	Filename used for dataset identification.

lake	-	Name of the lake (current or past) from which the sediment core was taken.
analysis_method	-	The method that was used to generate the provided records in the dataset.
category	-	The category the dataset belongs to.
core_label	-	Name of the sediment core a dataset is derived from.
core_composite	TRUE / FALSE	If the sediment profile is derived from a composite of multiple cores (TRUE) or a single core (FALSE).
core_length	cm	Extend of the core or composite profile from end to end in centimetres.
coring_method	-	Method used for sediment core withdrawal.
core_water_depth	m	Water column depth at the core withdrawal location in metres.
core_sections	-	List of sections included in a core or composite profile.
coring_date	date	Date of core withdrawal. Recommended format: YYYY-MM-DD. Yet, the data type is "text" as the recommended format not always applicable.
core_latitude	DD.dddd	Latitude of the core withdrawal location (if applicable). Entered in decimal degrees. Negative values for South latitudes. (Coordinate system: WGS84)
core_longitude	DD.dddd	Longitude of the core withdrawal location (if applicable). Entered in decimal degrees. Negative values for West longitudes. (Coordinate system: WGS84)
core_comments	-	Comments can be added to provide special remarks about the core that are not represented by other columns.
reference_citation	-	Data source in apa (en-GB) citation style (https://citation.crosscite.org/).
reference_doi	-	Data source DOI (Digital Object Identifier, https://doi.org/).
reference_url	-	Data source (Uniform Resource Locator).
available_in_reset_database	-	Data availability in RESET database (https://c14.arch.ox.ac.uk/)
material	-	Classification of sampled matter.
material_description	-	Details about the nature of sampled material.
analysis_device	-	Laboratory instrument / equipment used to produce the sample data.
beam_diameter	µm	Size of the microprobe/laser beam
beam_current	nA	Intensity of the microprobe/laser beam
beam_accelerating_voltage	kV	Voltage of the microprobe/laser beam
measurement_unit	-	Measurement unit for the numerical values of element

		analysis.
standard	-	Standard material used for analytical calibration e.g. Lipari Obsidian.

Table 2 Field names for the table "Dataset"

4.3.3 Table 3: Tephra Major Elements

Column header	Unit	Description
data_availability	-	Possible values: „No geochemistry“; „Raw data available“; „Only normalised values available“; „Only mean values available“
dataset	-	Identification of the corresponding dataset. Must match an entry in „Datasets.dataset“
lake	-	Name of the corresponding lake. Must match an entry in „Lakes.lake“
geochemistry_available	TRUE / FALSE	Simplified data availability filter.
correlation	-	Name of the correlated tephra layer. Option for 'Unknown'.
sample_id	-	Lab code or ID used to identify the sample.
source	-	Volcanic origin of the tephra layer; Option for 'Unknown'
lab	-	Laboratory/Institution where analysis was undertaken
analytical_method	-	Type of geochemical analysis undertaken e.g. WDS EPMA
SiO ₂	wt%	Weight total % of Silicon (separate fields for raw and normalised values)
TiO ₂	wt%	Weight total % of Titanium dioxide (separate fields for raw and normalised values)
Al ₂ O ₃	wt%	Weight total % of Aluminium oxide (separate fields for raw and normalised values)
FeO(t)	wt%	Weight total % of Iron oxides (separate fields for raw and normalised values)
MnO	wt%	Weight total % of Manganese oxide (separate fields for raw and normalised values)
MgO	wt%	Weight total % of Magnesium oxide (separate fields for raw and normalised values)
CaO	wt%	Weight total % of Calcium oxide (separate fields for raw and normalised values)
Na ₂ O	wt%	Weight total % of Sodium oxide (separate fields for raw and normalised values)
K ₂ O	wt%	Weight total % of Potassium oxide (separate fields for raw and normalised values)

P2O5	wt%	Weight total % of Phosphorus pentoxide (separate fields for raw and normalised values)
SO2	wt%	Weight total % of Sulphur dioxide (separate fields for raw and normalised values)
Cl	wt%	Weight total % of Chlorine (separate fields for raw and normalised values)
F	wt%	Weight total % of Fluorine (separate fields for raw and normalised values)
total	wt%	Sum of Weight total % of all elements (separate fields for raw and normalised values)
dated_in_core	TRUE / FALSE	Have the publishing authors dated the tephra layers in situ?
age_transfer_reference	-	If dated_in_core = „FALSE“, provide DOI of the reference for the age of the tephra recognised by the authors.
age_calbp	yr BP	Estimated age of the tephra layer in calibrated years before present (either in situ or external age).
cal_age_mean	yr BP	Mean tephra age (Optional).
cal_age_median	yr BP	Median tephra age (Optional).
uncertainty_years	years	Uncertainty of the tephra age in +/- years.
sigma	-	Confidence window of the age uncertainty: 1 = 68%, 2 = 95.4%, 3 = 99.7%, 4 = 99.9%.
calibrated	TRUE / FALSE	Has the tephra age provided been calibrated in any way (e.g. using 14Cs)?
dating_method	-	Method used for dating the tephra layer e.g. varve counting, 14Cs, age modelling.
depth	cm	What depth within the lake sequence/core was the tephra identified at?
depth_unit	-	Unit of measurement for the depth of tephra layers.
comments	-	Additional relevant information not aligned with any other field entry.
primary_data_source	DOI	DOI or URL of the primary paper that published the tephra geochemical data.

Table 3 Field names for the table “Tephra Major Elements”

4.3.4 Table 4: Tephra Trace Elements

Column Head	Unit	Definition
dataset	-	Identification of the corresponding dataset. Must match an entry in „Datasets.dataset“.

lake	-	Lake corresponding to data point.
geochemistry_available	-	Simplified data availability filter.
correlation	-	Name of the correlated tephra layer. Option for 'Unknown'.
sample_id	-	Lab code or ID used to identify the sample.
source	-	Volcanic origin of the tephra layer; Option for 'Unknown'.
lab	-	Laboratory/Institution where analysis was undertaken.
analytical_method	-	Type of geochemical analysis undertaken e.g. WDS EPMA.
Rb	ppm	Concentration in rubidium
Sr	ppm	Concentration in strontium
Y	ppm	Concentration in yttrium
Zr	ppm	Concentration in zirconium
Nb	ppm	Concentration in niobium
Ba	ppm	Concentration in barium
La	ppm	Concentration in lanthanum
Ce	ppm	Concentration in cerium
Pr	ppm	Concentration in praseodymium
Nd	ppm	Concentration in neodymium
Sm	ppm	Concentration in samarium
Eu	ppm	Concentration in europium
Gd	ppm	Concentration in gadolinium
Dy	ppm	Concentration in dysprosium
Er	ppm	Concentration in erbium
Yb	ppm	Concentration in ytterbium
Lu	ppm	Concentration in lutetium
Ta	ppm	Concentration in tantalum
Th	ppm	Concentration in thorium
U	ppm	Concentration in uranium
unit	-	ppm
std_file	-	Refers to the standard used, the primary datasource will have published standards alongside geochemistry.
primary_data_source	DOI	DOI or URL of the primary paper that published the tephra geochemical data.

Table 4 Field names for the table "Tephra Trace Elements"

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