Open Access History of Geo- and Space Sciences Discussions

Hist. Geo Space. Sci. Discuss., author comment AC1
https://doi.org/10.5194/hgss-2021-22-AC1, 2022

Comment on hgss-2021-22

David J. Lowe et al.

Author comment on "Global tephra studies: role and importance of the international tephra research group "Commission on Tephrochronology" in its first 60 years" by David J. Lowe et al., Hist. Geo Space. Sci. Discuss., https://doi.org/10.5194/hgss-2021-22-AC1, 2022

Response to comments from Prof Ray Cas (reviewer 1)

We very much appreciate Ray's comments, suggestions, and general support for the paper. Our responses are given below in **normal font.** We show Ray's overall comments first and then respond to specific comments in his report and those made on the MS itself following the order of the article (Sections 1, 2, 3.3); Ray's comments are indicated.

Ray: Overview

Ray: This is a well-structured overview of the initiation and evolution of the Commission on Tephrochronology, in its various guises and under various host organisations. It has surprised this reviewer how many changes COT has undergone, especially with hosting organisations. The review is generally well written, but becomes a little rambling in places, and could benefit from some new sub-sections to separate what appear to be disparate issues discussed under a heading that isn't always pertinent.

Ray: The historical facts about COT and the key personnel involved in managing and guiding COT appear to be thoroughly documented. Tables and images are relevant to the discussion and illustrative of key points made in the text, as well as being an important historical record. I recommend publication after minor revision.

Authors:

Many thanks for the positive comments. We deal with the 'rambling' issue below under Section 3 below. We have added new subsections and shifted text that was out of place thereby sorting out the 'disparate' issues.

Section 1

In the introduction we have revised the definitions slightly of 'tephra' and 'cryptotephra' to meet a comment made on the MS itself

Ray: Is it worth summarising briefly the various sources of tephra samples and studies – modern pyroclastic deposits sequences, tephra in soils, lake deposits, ocean floor sediments and deep sea cores, ice cores, and how the search and sampling of tephra in

these different settings developed as technology developed?

This is an interesting and good suggestion because there are progressions and connections with the type of deposit and archive of study and the method of analysis, but with overlap (e.g. see Lowe et al., 2017). Quite a few links between deposit and method are noted in the COT article chronologically through the narrative (rather than as a separate section). To help enhance the developmental links in the COT article, we have rearranged the introduction a little and concluded it with a new header – *1.1 Development of cryptotephra studies* – in which we briefly note the progression of different sorts of archives used to target distal and ultradistal cryptotephra deposits. We provide more discussion below. Work being undertaken elsewhere by one of the authors for a book will include a timeline of advances in the discipline including types of materials described and analysed from different archives.

Although the earliest studies of the modern era of tephrochronology (defined as beginning in late 1920s) focussed on mapping proximal deposits, at the same time thin, distal deposits were also being studied in peats mainly as a new stratigraphic correlational tool for palynology – for example by Finnish worker Auer in South America in late 1920s and early 1930s, and by Thorarinsson himself in Sweden (with von Post) and in Iceland in 1930s (in Iceland, Thorarinsson had an advantage in that he could work out the ages of some tephra layers via historical documentary accounts and hence use the layers as a dating tool) (Thorarinsson, 1944). In New Zealand, Grange (from 1926), together with Taylor in early 1930s, worked on distal tephra-derived soils (comprising composites of multiple thin tephra deposits), whilst Grange mapped thick proximal sequences of pyroclastics and lavas near their sources, i.e. proximal and distal deposits were both targeted simultaneously because of two different main aims: volcanic hazard analysis and to identify the cause of 'bush sickness' (later found to be Co deficiency) on pumiceous soils. The aim of evaluating the origins of tephric soils was also embedded in the studies of Thorarinsson.

We have documented previously how distal tephra deposits preserved in lake sediments and peats became the target of new studies from the late 1970s and 1980s alongside studies of such deposits in the marine setting (e.g. Lowe, 1990, 2011, 2014; Hopkins et al. 2021). In addition, we mention the development of new techniques and protocols in the COT text in the chronological narrative (e.g. citing Froggatt, 1992; Hunt and Hill, 1996; Kuehn et al., 2011).

The advent of modern cryptotephra studies from c. 1990 saw a new focus on distal and then ultradistal cryptotephras in ice cores and marine sediments from around that time (e.g. Lowe, 2008, 2014; Davies, 2015). The development of analytical techniques to allow the characterization of small glass shards for major elements and trace elements followed (e.g. Lowe, 2011; Hayward, 2012; Pearce et al. 2011, 2014; Pearce, 2014; Lowe al., 2017). Meanwhile, the ITPFT fission-track dating method for glass was developed (Westgate, 1989), an important advance because it allowed glass-dominated distal tephras to be directly dated for the first time (Lowe, 2011; Alloway et al., 2013). The application of U-series double dating of zircons is another new technique now taking off (e.g. see references in Hopkins et al., 2021). Most of these points are reported in the article.

Section 2

Material from Section 3.4 about the rationale for change from INQUA to IAVCEI (misplaced under a heading about funding) has been brought forward and amalgamated within section 2.2 with this revised header:

2.2 Hosting of commission by INQUA or IAVCEI since 1961, and reasons for change to

IAVCEI in 2019

In this section we discuss chronologically the nine meetings held by the commission, starting with Tokyo in 1964. An important discussion (previously without a header) about how the term 'tephra' was redefined in 1974, after the 1973 Christchurch INQUA Congress, has now been specifically identified with a new subsection heading placed chronologically between 1964 and 1980 meeting with this newheader:

2.3.2 Redefining 'tephra' after 1973 INQUA Congress, Christchurch, via Westgate and Gold (1974)

Section 3.3

Ray: The review is generally well written, but becomes ***a little rambling*** *in places, and could benefit from some new sub-sections to separate what appear to be disparate issues discussed under a heading that isn't always pertinent.*

Section 3.3, originally entitled "Key periods and circumstances in the development of COT", is the section identified as 'a little rambling' by Ray who suggested using some subheaders to focus the topics better. We agree and have revised the text and added new subheaders because this is a very important section. Section 3.3 has thus been renamed and split into three new subsections that identify the constituent topics more clearly as follows:

3.3 Decline and rise of COT since the 1980s: key events and protagonists

3.3.1 COT transforms to CEV

3.3.2 Renaissance from 1987

3.3.3 Growth from 1990s including advent of modern cryptotephra studies and development of new techniques

Ray: Why not "Tephrachronology'? Why "Tephrochronology"?

In many compound words in English based on Greek roots, the original final vowel ('a') (= alpha) is replaced with 'o' (= 'omicron' !) to form derivatives such as tephrostratigraphy, tephrochronology, and teprochronometry (Froggatt & Lowe, 1990; Lowe and Hunt, 2001; Lowe, 2011). In Latin, a connecting 'i' is used. A similar principle was used in developing the Greek- and Latin-derived nomenclature of 'Soil Taxonomy' (Soil Survey Staff 1999), an international soil classification system. We have added a sentence to the introduction explaining why the derivative word 'tephrochronology' (and other derivatives) is spelt correctly on the basis of the rule noted above.

References cited above

Alloway, B.V., Lowe, D.J., Larsen, G., Shane, P.A.R., and Westgate, J.A.: Tephrochronology, in The Encyclopaedia of Quaternary Science, 2nd edition, edited by Elias, S.A., Mock, C.J., Elsevier, Amsterdam, 4, 277-304, 2013.

Davies, S.M.: Cryptotephras: the revolution in correlation and precision dating. Journal of Quaternary Science 30, 114-130, 2015.

Froggatt, P.C.: Standardization of the chemical analysis of tephra deposits. Report of the ICCT working group. Quaternary International 13-14, 93–96, 1992.

Hayward, C.: High spatial resolution electron probe microanalysis of tephras and melt inclusions without beam-induced chemical modification. The Holocene 22, 119-125, 2012.

Hopkins, J.L., Lowe, D.J., and Horrocks, J.H.: Tephrochronology in Aotearoa New Zealand. New Zealand Journal of Geology and Geophysics 64 (2/3), 153-200, 2021.

Hunt, J.B. and Hill, P.G.: An inter-laboratory comparison of the electron probe microanalysis of glass geochemistry. Quaternary International 34-36, 229–241, 1996.

Kuehn, S.C., Froese, D.G., Shane, P.A.R., and INTAV intercomparison participants: The INTAV intercomparison of electron-beam microanalysis of glass by tephrochronology laboratories: results and recommendations. Quaternary International 246, 19–47, 2011.

Lowe, D.J.: Tephra studies in New Zealand: an historical review. Journal of the Royal Society of New Zealand 20, 119–150, 1990.

Lowe, D.J.: Globalization of tephrochronology: new views from Australasia. Progress in Physical Geography 32, 311-335, 2008.

Lowe, D.J.: Tephrochronology and its application: a review. Quaternary Geochronology 6, 107-153, 2011.

Lowe, D.J.: Marine tephrochronology: a personal perspective. Geological Society, London, Special Publications 398, 7-19, 2014.

Lowe, D.J., Pearce, N.J.G., Jorgensen, M.A., Kuehn, S.C., Tryon, C.A., and Hayward, C.L.: Correlating tephras and cryptotephras using glass compositional analyses and numerical and statistical methods: review and evaluation. Quaternary Science Reviews 175, 1-44, 2017.

Pearce, N.J.G.: Towards a protocol for the trace element analysis of glass from rhyolitic shards in tephra deposits by laser ablation ICP-MS. Journal of Quaternary Science, 29, 627-640, 2014.

Pearce, N.J., Westgate, J.A., Perkins, W.T., and Wade, S.C.: Trace-element microanalysis by LA-ICP-MS: the quest for comprehensive chemical characterisation of single, sub-10-μm volcanic glass shards. Quaternary International 246, 57-81, 2011.

Pearce, N.J.G., Abbott, P.M., and Martin-Jones, C.M.: Microbeam methods for the analysis of glass in fine grained tephra deposits: a SMART perspective on current and future trends. Geological Society, London, Special Publications 398, 29-46, 2014.

Soil Survey Staff: Soil Taxonomy, 2nd edition. USDA Natural Resources Conservation Service Agriculture Handbook 436. 869 pp, 1999.

Thórarinsson, S.: Tefrokronologiska studier på Island. Geografiska Annaler 26, 1–217, 1944.

Westgate, J.A. 1989. Isothermal plateau fission-track ages of hydrated glass shards from silicic tephra beds. Earth and Planetary Science Letters 95, 226–234, 1989.