Bulletin of Volcanology (2019) 81: 69
https://doi.org/10.1007/s00445-019-1328-3

EDITORIAL

Preface to the topical collection—pyroclastic current models: benchmarking and validation

Greg A. Valentine [1]

Received: 31 July 2019 / Accepted: 1 October 2019 / Published online: 9 November 2019

Pyroclastic currents are a long-standing research focus in volcanology. They involve multiphase flow processes that produce a wide range of deposits and that comprise a major source of volcanic hazard and risk. Note that the term pyroclastic current is used here in lieu of a variety of other terms such as nuée ardentes, ash flow, pyroclastic flow, volcanic base surge, pyroclastic flow, pyroclastic surge, and pyroclastic density current (c.f. LaCroix 1904; Ross and Smith 1961; Moore 1967; Fisher 1979; Branney and Kokelaar 2002). Early work focused on interpreting pyroclastic current processes through detailed field and sedimentological studies of deposits (e.g., Fisher and Waters 1970; Sparks 1976; Walker 1983; Wilson 1985). Process-related questions naturally led to theoretical studies that have grown in sophistication over the past four decades, while in parallel, the need to forecast some aspects of pyroclastic currents (such as runout, temperature, dynamic pressure, and depth) for hazard mitigation applications provided additional impetus for theoretical model development (e.g., Sparks et al. 1978; Valentine and Wohletz 1989; Neri et al. 2003; Patra et al. 2005). The complexity of pyroclastic current physics, involving a wide range of multiphase flow regimes, means that most theoretical models are solved by computation-intensive numerical approaches rather than analytical methods. Experimental research grew alongside field and theoretical work, ranging from analog experiments to focused work on granular flows and dilute currents (e.g., Bursik and Woods 2000; Roche et al. 2008; Andrews and Manga 2011) and, in the past decade, to large-scale experiments on the scales of tens of meters that are aimed at including as much of the relevant physics, compared with natural pyroclastic currents, as possible (Dellino et al. 2007; Lube et al. 2015).

Although many questions remain, our understanding of pyroclastic currents has accelerated in the past 15 years. This acceleration was complemented by several workshops that centered on identifying key problems and the importance of linking field, experimental, and modeling research. The most recent of these was held in January 2019 in New Zealand (Taupo and Palmerston North) and was co-organized by researchers at Massey University and Istituto Nazionale de Geofisica e Vulcanologia. That workshop focused entirely on the comparison of pyroclastic current models with experimental data for the purpose of validation (assessing how well a computational model represents the physical problem at hand) and benchmarking (comparison of different computational models with one another, using a well-defined dataset to define a problem). Workshop attendees concluded that experimental datasets and computational models have matured sufficiently to build momentum towards a community-driven effort that supports benchmarking and validation (B&V) of pyroclastic current models.

This Topical Collection is aimed at supporting such a community-driven effort by providing a platform for researchers to publish emerging B&V work and to serve as a resource for those interested in contributing to and/or participating as we further advance our modeling capabilities and our understanding of the strengths and weaknesses of pyroclastic current models. The Collection opens with a Perspectives paper by Esposti Ongaro et al. that presents a framework for benchmarking and validation, along with a brief review of the main classes of pyroclastic current models. Additional papers will include the following: (1) detailed descriptions of specific experiments (lab-scale and large-scale) and resulting datasets that can be used for B&V; (2) B&V results for specific models; (3) field datasets (from observed currents or deposits) that are sufficiently constrained for use as

This paper constitutes part of a topical collection:
Pyroclastic current models: benchmarking and validation

Editorial responsibility: N. Fournier

✉ Greg A. Valentine
gav4@buffalo.edu

[1] Department of Geology and Center for Geohazards Studies, University at Buffalo, Buffalo, NY 14260, USA

B&V cases. Manuscripts accepted for the Topical Collection will both be published as normal *Bulletin of Volcanology* papers and be flagged for the Collection. The Topical Collection will remain open for submissions over the next 2–3 years, or longer if additional contributions are anticipated. Indeed, B&V is never really "complete," as pointed out in the Esposti Ongaro et al. Perspectives paper; a high level of community effort and desire to publish the resulting work could extend the open period for the Collection.

Finally, I thank colleagues who participated in the engaging discussions at the 2019 New Zealand workshop, which led to this Topical Collection and, in particular, Tomaso Esposti Ongaro, Gert Lube, and Sylvain Charbonnier, who have played key roles in initiating and promoting a community-driven benchmarking and validation initiative.

References

Andrews BJ, Manga M (2011) Effects of topography on pyroclastic density current runout and formation of coignimbrites. Geology 39: 1099–1102. https://doi.org/10.1130/G32226.1

Branney MJ, Kokelaar P (2002) Pyroclastic density currents and the sedimentation of ignimbrites. Geol Soc Memoir 27

Bursik MI, Woods AW (2000) The effects of topography on sedimentation from particle-laden turbulent density currents. J Sed Res 70:63–63

Dellino P, Zimanowski B, Büttner R, La Volpe L, Mele D, Sulpizio R (2007) Large-scale experiments on the mechanics of pyroclastic flows: design, engineering, and first results. J Geophys Res 112: B04303. https://doi.org/10.1029/2006JB004313

Fisher RV (1979) Models for pyroclastic surges and pyroclastic flows. J Volcanol Geotherm Res 6:305–318

Fisher RV, Waters AC (1970) Base surge bed forms in maar volcanoes. Am J Sci 268:157–180

LaCroix A (1904) La Montagne Pelée et ses eruptions. Masson et Cie, Paris

Lube G, Breard ECP, Cronin SJ, Jones J (2015) Synthesizing large-scale pyroclastic flows: experimental design, scaling, and first results from PELE. J Geophys Res Sol Earth 120:1487–1502. https://doi.org/10.1002/2014JB011666

Moore JG (1967) Base surge in recent volcanic eruptions. Bull Volcanol 30:337–363

Neri A, Esposti Ongaro T, Macedonio G, Gidaspow D (2003) Multiparticle simulation of collapsing volcanic columns and pyroclastic flow. J Geophys Res 108:2202. https://doi.org/10.1029/2001JB000508

Patra AK, Bauer AC, Nichita CC, Pitman EB, Sheridan MF, Bursik M, Rupp B, Webber A, Stinton AJ, Namikawa LM, Renschler CS (2005) Parallel adaptive numerical simulation of dry avalanches over natural terrain. J Volcanol Geotherm Res 139:1–21. https://doi.org/10.1016/j.jvolgeores.2004.06.014

Roche O, Montserrat S, Niño Y, Tamburrino A (2008) Experimental observations of water-like behavior of initially fluidized, dam break granular flows and their relevance for the propagation of ash-rich pyroclastic flows. J Geophys Res 113:B12203. https://doi.org/10.1029/2008/JB005664

Ross CS, Smith RL (1961) Ash-flow tuffs: their origin, geologic relations and identification. US Geol Surv Prof Pap 366

Sparks RSJ (1976) Grain size variations in ignimbrites and implications for the transport of pyroclastic flows. Sedimentology 23:148–188

Sparks RSJ, Wilson L, Hulme G (1978) Theoretical modeling of the generation, movement, and emplacement of pyroclastic flows by column collapse. J Geophys Res 83:1727–1739

Valentine GA, Wohletz KH (1989) Numerical models of Plinian eruption columns and pyroclastic flows. J Geophys Res 94:1867–1887

Walker GPL (1983) Ignimbrite types and ignimbrite problems. J Volcanol Geotherm Res 17:65–88

Wilson CJN (1985) The Taupo eruption, New Zealand II: the Taupo ignimbrite. Phil Trans R Soc London Ser A 314:229–310