Natural Hazards
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Discussions

NHESSD

3, C2357–C2365, 2015

**Interactive
Comment**

Interactive comment on "Evaluation of the initial stage of the reactivated Cotopaxi volcano – analysis of the first ejected fine-grained material" *by* T. Toulkeridis et al.

Anonymous Referee #1

Received and published: 25 November 2015

The m/s entitled "*Evaluation of the initial stage of the reactivated Cotopaxi volcano – analysis of the first ejected fine-grained material*" by Toulkeridis et al. provides a rapid study of the ash emitted during the reactivation phase of Cotopaxi volcano, including such parameters as ash composition, lithics content, grain-size distribution and some morphology. The authors reached the conclusion that no juvenile magma was involved with the August 2015 eruption and suggest a shallow hydrothermal cause to the reactivation rather than a deep magmatic source. Such a rapid study, although somehow basic, is highly relevant for a high-risk volcano such as Cotopaxi, and the rapid response in characterizing the ash is a first step towards constraining eruption scenarios that can in turn be used to inform authorities. It is also a step towards a near real-time

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Interactive Discussion

Discussion Paper

characterization of the total grain-size distribution of tephra fallout, which is crucial for such authorities as VAACs to assess the potential impact on the air traffic.

With this merit in mind, the main issue with this m/s is that both the aims and the conclusions seem to be somehow disconnected with the analyses presented throughout the text. For instance, since the main conclusion of the paper is that the August 2015 activity is non-magmatic. I don't think it is possible to jump to conclusions on 1) the frequency/probability of such events or 2) the magnitude of lahars without further detailed development on these respective topics. Why not, on a volcanological point of view, stick to the valuable data this study found without drawing broad conclusions that are scientifically less relevant and, on a natural hazard point of view, add a proper discussion section tackling critical aspects such as crisis management and on the use of such volcanological data to inform authorities? The volcanological community can learn a lot from crisis management in Ecuador.

The analysis of wind data is somehow a new approach compared to what is usually achieved in probabilistic studies of wind directions. Unfortunately, the authors refer to a m/s that is not published yet. Should the present m/s be accepted for publication first, it would be good to add some words about the technique and potentially a comparison with the traditional methods based on Reanalyses databases (e.g. NOAA, ECMWF. . .).

The m/s could also benefit from the use of more recent literature, both in the introduction and on the general hazard related to tephra in Ecuador. For this last aspect, this recent papers are available and, although treating of larger eruptions, could be used to expand a discussion:

- Biass S, Bonadonna C (2013) A fast GIS-based risk assessment for tephra fallout: the example of Cotopaxi volcano, Ecuador-Part I: probabilistic hazard assessment. Nat Hazards 65:477–495.

- Biass S, Frischknecht C, Bonadonna C (2013) A fast GIS-based risk assessment for tephra fallout: the example of Cotopaxi volcano, Ecuador - Part II: vulnerability and risk assessment. Nat Hazards 65:497–521.

- Tsunematsu K, Bonadonna C (2015) Grain-size features of two large eruptions from Cotopaxi volcano (Ecuador) and implications for the calculation of the total grain-size distribution. Bull Volcanol 77:1–12. doi: 10.1007/s00445-015-0949-4

- Volentik AM, Houghton B (2015) Tephra fallout hazards at Quito International Airport (Ecuador). Bull Volcanol 77:1–14. doi: 10.1007/s00445-015-0923-1

Finally, this m/s could benefit from involving a native English speaker as the understanding of some parts is complicated by misused grammar. Also, attention should be given to references, as some are badly referenced and other are missing. As a result, I suggest major revisions.

P6948

- L4: Wind directions cannot be charged with ash, though clouds could. Rephrase

- L5: I do not agree that outcomes of this manuscript could be used as measures for local warning. This is a misleading outcome that should be reformulated

- L6: Ash fallout, not precipitation

- L8: Basic analyses were performed on the collected samples such as ash morphology, mineral content and chemical composition

- L9: What do you mean with rock fragments? Lithics?

- L15: There is something missing in this sentence

- L14-17: This m/s gives no information on concepts such as "frequent", "low probability" and "catastrophic" eruptions. I would avoid drawing dangerous and potentially misinterpreted conclusions regarding the probability of a future eruption and would strictly stick to the conclusion that present observations show that the reactivation contains no juvenile material.

- L19-26: This first paragraph is i) very general, ii) contains a low level of information and iii) is based on old references (i.e. the past decade abounds with literature on the impact of eruptions). Additionally, there is now a general recognition that tephra is a very problematic hazard, and is not really underestimated anymore.

P6949

- L5: What eruptions were associated with major lahar events (i.e. eruptive style, VEI etc)

- L6: Aguilera and Toulkeridis (2005) is missing from the reference list

- L8: Large eruptions

- L11: "of volcanic activity"

- L26: Figure 1 does not show "four morphologically distinctive volcanic chains"

P6950

- L2: Delete "and represents a natural laboratory for the assessment of volcanic hazards"

- L3-5: Rephrase. Eg: "The historical activity of the active snow-capped crater is well documented"

- L14-16: Barberi et al. (1995) and Mothes et al. (2008) mention a drastic change in the regime of the volcano (i.e. rhyolite to andesite). It is maybe worth mentioning this aspect when addressing a flank collapse scenario.

- L20-22: Is the relationship between extent of the glacier and magnitude of the lahar entirely correct? What about the effect of eruption type/size?

- L22: Avoid alarmist "loss of life" aspects and stick to an increased exposure

- L26: Delete "unfortunately"

- L29: Delete "other"

P6950

- L1: Barberi et al. (2005) missing from reference list

- L4-5: Such statistical analyses of probability of a future eruption rely on heavy assumptions. Reporting such probabilities without stating the assumptions can be misleading. Either describe methods or delete. Additionally, Biass and Bonadonna (2013) provide some statistical analyses and the underlying assumptions.

- L8-9: It is somehow difficult for the reader to refer to that many conference abstracts. Isn't there any recent publication that summarizes the recent activity?

- L17: What clear precursor?

- L18-20: It could be useful to have an idea of the plume heights associated with the various explosions, which could be put in parallel of the evolution of the grain-size.

- L21-24: For clarity, it could be useful to add the distance of the outcrops from the vent both in the text and in Table 1. Adding the outcrop labels on Figure 2 could also be useful.

P6951

- L4: What do you mean by "19196 data"?

- L4-14: This is a very interesting technique and it is unfortunate that the mentioned article is not available yet. Could you add further information? For example, do you track volcanic emissions? Do you get wind directions only when these occur? If yes, how do you assess the completeness? How does such an approach compare to Reanalysis-based approaches such as Biass and Bonadonna (2013) or Volentik and Houghton (2015)?

- L8: Altitudes of ash clouds vary

- L9: "with two predominant heights between FL200 and FL250 and between FL 300 and FL400, together containing 98 % of all available data "

P6953

- L21: Bizarre use of the reference of Monzier et al. (1999), as it dates before any of the crises mentioned above

- L25: Delete "Therefore, the non-warning of such precursor did not really surprise". Please do stick to objective comments.

- L26: 8 km. Please mention whether a.s.l. or above vent

P6954

- L1-3: Rephrase sentence. What do you mean by "emplacement"? Tephra fallout?

- L5: 5'400 m is ∼500 m below the vent altitude. Please explain

- L6-7: Rephrase.

- L8: 5 km asl

- L11-12: Same comment as L25 of previous page. Although that might be entirely true, this might not be scientifically relevant nor objective. Why not change to: "Therefore, the change of the alert status of the Cotopaxi volcano occurred solely due to the visibility of the explosive event of 10:25 ECT (Fig. 3)"

- L25: Can you estimate a probability of this wind direction?

P6955

- L1: Therefore, further samples were taken in Lasso along the main dispersal axis.

- L23: 8 km asl?

- L24: Groundwater?

P6956

- L7-8: Rephrase. Proximal samples are characterized by S-rich composition whereas distal samples are enriched in Fe, Mg and Mn.

- L11: The largest difference amongst samples is the sulfur concentration.

- L19: "very first eruption event" -> initial phase

- L20: Change "precipitation" to fallout

- L19-21: Rephrase in order to avoid single sentence paragraphs

P9657

- L1: Unclear. Does that imply that the finest fraction is underestimated from your analysis and in Fig 8 and 9? Clarify

- L2: "in Table 2"

- L6-9: Couldn't that be due to aggregation and rafting processes? Aggregation typically increase the fine fraction, but rafting can also create a secondary coarse maximum (e.g. COT1408 1, 2 and 4)

- L14: The conclusion almost entirely consists of single sentence paragraphs. Consider rewriting. Please stick to the conclusions of your study.