

Interactive comment on “Integrating field, textural and geochemical monitoring to track eruption triggers and dynamics: a case-study from Piton de la Fournaise” by Lucia Gurioli et al.

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Summary:

This paper highlights the importance of combining textural, chemical and petrological data to describe volcanic eruptions. Employing this multidisciplinary approach, the authors provide a narrative for transition in eruption activity during the 2014 eruption at Piton de La Fournaise, la Reunion. The bulk of interpretations made by the authors come from four pyroclast typeologies that were produced over the course of the eruption from the Main Vent and Western Fracture. Melt inclusion data indicates a single, heterogeneous magma source. The clasts record a cooler, relatively crystal-rich, de-

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gassed, portion of magma along with a hotter, volatile-rich portion. Gas accumulation in the shallow reservoir, released from the cooler, crystal-rich magma, contributed to the fast ascent rate or hotter magma. This resulted in the hawaiian fire-fountain activity. The authors propose successive tapping of the reservoir caused the decrease in explosive intensity. The conclusions are reasonable given the observational and analytical data. This work provides a wealth of data that will no doubt be useful for future study and comparison. However, I think the paper could better exemplify the multi-disciplinary approach and strengthen its conclusions by incorporating more equal weight/description to each component. I recommend this paper to be accepted after minor/moderate revision which I have detailed in the following text.

General Comments:

I was intrigued when I saw permeability data would also be included, (pg.7 lines 208-210, “more than 200 clasts of similar size (maximum diameter between 16 and 32 mm, see Gurioli et al. 2015) were collected, both close to the Main Vent and in the ‘distal’ area (30 metres away from the vent) for density, connectivity, permeability, petrological and geochemical analysis”) however, the paper does not present any permeability data. In Supplementary table S1, I see that it was performed on some samples. It would be interesting to see how that data adds to the interpretation of eruptive activity. Also, I think it would also be a more intuitive measurement than isolated/connected vesicularity.

I would like to see a more detailed discussion of the crystallinity data given the large impact of crystals on bubble deformation, connectivity/permeability (Spina et al. 2016, Lindoo et al. 2017), volatile distribution in the conduit (Parmigiani et al. 2011, Parmigiani et al. 2016), and ultimately eruptive style.

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Does the paper address relevant scientific questions within the scope of SE?

The authors present observational and analytical data that contribute to furthering our understanding of transitions in eruption dynamics. The manuscript includes information of interest to a range of sub-disciplines including seismology, physical volcanology, geochemistry, and igneous petrology.

Does the paper present novel concepts, ideas, tools, or data?

The paper presents conventional methods of describing eruption products. The multidisciplinary approach in combining bulk textural and geochemical data into one paper sets a standard for future papers in describing volcanic deposits. However, some of the components could use more detail.

Are substantial conclusions reached?

The authors address most of the research questions posed in the introduction, which are best summarized in the conclusion section. I did not come away with a clear understanding of their first (i: why was such a small volume of magma erupted instead of forming an intrusion) or fifth (v: What was the time and space evolution of the eruptive event) objectives.

Are the scientific methods and assumptions valid and clearly outlined?

The methods employed in the study are generally well described, with the exception of a few points:

The authors employ circularity to characterize different clast types. First, how many particles of each typeology were measured using the Morphologi G3? I would also suggest the use of at least three shape descriptors, as recommended by Liu et al. 2015, to fully describe particle morphologies. Currently, the use of a shape descriptor in the interpretation of the eruptive products comes across as an afterthought. Because circularity is not really utilized in the description/interpretation of the products,

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the section could just be removed. I do think it would be interesting to see if other shape descriptors (such as solidity and convexity) may better describe the relationships between particle shapes and eruption styles.

Why were only 25 clasts from the Western Fracture analyzed versus 146 from the Main Vent? I'm speculative whether the number of clasts accurately samples the Western Fracture explosion. Also, I do not find it clear how clasts were picked for analyzing vesicle size distributions. I find the Spiny Glass and Golden pumice density distributions to be slightly bimodal (Fig. 6c). Do the stars in Fig. 6 denote the mode determined for each component? This should be noted in the figure caption as well.

I do not see a table that includes all of the crystallinity data (vol. Crystallinity data could be inserted into Table 3 in the connected vesicle or isolated vesicle column, as it's not necessary to have both (connected/isolated) listed. There is some description in the results (phases present), but I find it difficult to follow without a table to reference/compare. I would also be interested to see the phase abundances and aspect ratios. The amount of crystals (specifically high aspect ratio plagioclase) coupled with the vesicularity data, may give more insight into efficient vs. inefficient degassing in the different typeologies (see Shea et al. 2017). The amount of crystals (depending on the aspect ratio) will influence degassing as well (Lindoo et al. 2017).

Are the results sufficient to support the interpretations and conclusions?

The results support the interpretations and conclusions made by the authors. I would ask the authors to also consider the effect of crystals on the permeability of the "degassed, cooler reservoir" along with their interpretation of reservoir tapping. Crystals increasing bubble connectivity/permeability of the reservoir alone may contribute to extensive degassing and shifts in eruptive style.

Is the description of experiments and calculations sufficiently complete and pre-

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cise to allow their reproduction by fellow scientists (traceability of results)?

Yes

Do the authors give proper credit to related work and clearly indicate their own new/original contribution?

Yes

Does the title clearly reflect the contents of the paper?

Yes

Does the abstract provide a concise and complete summary?

Yes

Is the overall presentation well structured and clear?

I find the manuscript to be fairly well structured. Section 5.2 might benefit from sub-sections or reorganization, perhaps divided by the different typologies, sampling area, or interpretation and comparison to other studies. There is a lot of information presented and comparison to other studies.

Is the language fluent and precise?

Yes

Are mathematical formulae, symbols, abbreviations, and units correctly defined and used?

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Yes

Should any parts of the paper (text, formulae, figures, tables) be clarified, reduced, combined, or eliminated?

Lines 99-105 – Reassess/reorganize the questions posed here. There are 5 questions listed with (iv) and (v) attached to (iii). I suggest separating each question with a paragraph or do not separate them. Also, I do not think questions (i) or (v) were addressed in the discussion/conclusions section.

Table 3 does not need both connected vesicularity and isolated vesicularity listed.

Figure 5c needs a more descriptive caption. I'm not sure what I and II refer to or the arrows (the clasts pictured?). I think the caption only describes one of the two graphs?

Figure 6c – please clarify the meaning of the star symbols

Figure 11 could be redrafted to provide more clarity to the reader. I would move the references to the figure caption to make room for an inset similar to Stovall et al. 2011 to help the reader interpret trends.

Are the number and quality of references appropriate?

89 references - I think the number of the references could be reduced.

Is the amount and quality of supplementary material appropriate?

Yes. Some formatting issues with supplementary tables.

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Minor corrections:

Line 111 – I would recommend removing this final sentence. The authors make it clear earlier in the introduction the importance of the multi-disciplinary approach.

Line 218 – Should reference Fig. 3e not 3f?

Line 310 – Combine the two sentences with the rest of the paragraph.

Line 331 – Should reference Figure 3b?

Line 510 – subscript “wr” in MgOwr.

Line 645 – reference numbers for comparison to Houghton et al. 2016.

General - Vg/Vl should be Vg/Vl. Subscript “v” in Nv.

Figure 1 – An inset map of Reunion Island would be helpful. (1c) is very dark/difficult to see.

Figure 3c – The pictures are so small it is difficult to see.

Figure 3e – 2010, Fountaining is spelled wrong.

Figure 10 – Inconsistent figure formatting. Thick axes lines and bold axes values

Missing or incorrect references:

Bombrun et al. 2015 (line 703)

Di Muro et al. 2012 (line 126)

Gurioli et al. 2008 (line 633)

Hammer et al. 1999 (line 750)

Inman 1952 (line 223)

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Liuzzo et al. 2015 (line 134)

Morandi 2015 (line 72)

Line 58 – Taddeucci misspelled

Line 60 – Extra “and”

Line 60 – Eychenne misspelled.

Line 61 – Should read “Leibrandt and Le Penneç, 2015”.

Line 600 – references in italics.

Line 971 – Should read “Lange, R.A., . . .”

Line 1016/1020 – reference chronology inconsistent.

Line 1023 – delete “a” from reference.

References cited:

Lindoo, A., Larsen, J. F., Cashman, K. V., and Oppenheimer, J., 2017, Crystal controls on permeability development and degassing in basaltic andesite magma: *Geology*, 45(9), p. 831-834.

Liu, E. J., Cashman, K. V., Rust, A. C., 2015, Optimising shape analysis to quantify volcanic ash morphology: *GeoResJ*, 8, p. 14-30.

Parmigiani, A., Huber, C., Bachmann, O., and Chopard, B., 2011, Pore-scale mass and reactant transport in multiphase porous media flows: *Journal of Fluid Mechanics*, v. 686, p. 40-76.

Parmigiani, A., Faroughi, S., Huber, C., Bachmann, O., Su, Y, 2016, Bubble accumulation and its role in the evolution of magma reservoirs in the upper crust: *Nature*, 532,

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p. 492-494.

Spina, L., Cimarelli, C., Scheu, B., Di Genova, D., and Dingwell, D. B., 2016, On the slow decompressive response of volatile- and crystal-bearing magmas: An analogue experimental investigation: *Earth and Planetary Science Letters*, v. 433, p. 44-53.

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