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Interactive comment on “Can vesicle size distributions predict eruption intensity during volcanic activity?” by A. LaRue et al.

A. LaRue et al.

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Reviewer #2 This study presents new and interesting data on vesicle-size distributions from Eyjaf- jallajökull tephra and comparison with VSD’s from experimental clasts produced during active vesiculation with and without quenching by water. I think the new data are worthy of publication, but I have some comments about both the methodology and the general premise of the paper.

Comment 1: Most significantly, the title and the last few sentences of the paper suggest that deter- mining vesicle size distributions can be a method of predicting eruptive activity. I can’t imagine how VSD’s can predict future behavior, nor do the authors explain this. I sug- gest they change the word “predict” to “quantify” in the title of the paper, and change the wording on p. 792 (lines 3-7) and p. 799 (lies 22-24) to

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emphasize quantification rather than prediction.

Reply: We have changed the title of the revised paper from “predict” to “assess” in light of this comment, as well as comments by Reviewer 1. We have also modified some of the sentences in the manuscript.

Comment 2: The authors should add a few sentences to the Discussion section considering the limits of application of these results. At Kilauea, one can collect fist-sized clots of lava near the ocean entry that have deformed through turbulent mixing with water while still fluid. Those clots have odd vesicle shapes, and any measure of bubble (or void) size distribution would show clear influence of water. The degree of influence should be related to the length scales of mixing and the time of mixing relative to vesiculation.

Reply:

In response to this comment we have changed the sentence at the end of section 4.3 from: “This relationship between the eruption intensity to the power-law exponent of the VSDs can thus be used as a key to the interpretation of natural scoria samples.” to: “This relationship between the eruption intensity to the power-law exponent of the VSDs can thus be used as a key to the interpretation of natural scoria samples that have not suffered post-eruption modification such as turbulent mixing with water while above the glass transition.”

Some other, more specific comments are below. Overall I think the paper is worthy of publication with minor changes.

Specific comments: Comment 3: p. 793, line 6: perhaps use the term “glass containing dissolved water” rather than “hydrated glass”. “Hydrated” generally means glass that has absorbed meteoric water at low temperature after solidification, whereas you are heating it to magmatic temperature under high pressure, and allowing the water to dissolve into a liquid melt.

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Reply: Within the experimental community (and in our previous publications) the term “hydrated glass” is used to describe glass into which water has been dissolved by any process, either high-temperature dissolution as in our case, or low-temperature dissolution as mentioned in this comment.

Comment 4: p. 793, line 8: what does “hydrous environment present during the Eyjafjallajökull eruption” mean? The water content of the magma chamber before ascent? The wet crater environment through which magma erupted?

Reply: We are referring to both the hydrous nature of the magma as well as the documented interaction between the magma and meteoritic water (ice) during eruption. In the revised text we have changed the word “environment” to “conditions” to make the meaning more clear.

Comment 5: Page 794, lines 5-6. Is there any way to say at what stage of vesiculation the clasts in the Argonne experiments were quenched? Can you rule out the possibility of ripening or other modification?

Reply: As stated in the paper, the experiments at Argonne were observed by x-ray radiography and therefore we know exactly the stage at which the samples were quenched and subsequently analyzed. During these experiments some forms of “ripening” can be observed; coalescence is the dominant mechanism affecting the number density of bubbles (they are not vesicles because they contain a gas during the experiments) as they expand and popping of a few bubbles at the surface is often seen. However, Ostwald ripening is never observed because of the short duration of the experiments and the $t^{1/3}$ power-law dependence of this process.

Comment 6: Page 795, line 16. If there was 1.7-4.1 wt% water dissolved in these melts, why was their vesicularity only 48+/-26%? Did the melt quench before it fully vesiculated?

Reply: In some cases the answer is “yes”. As in previous studies we tried to quench

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the system at different stages of vesiculation in order to investigate changes in the vesicle size distributions during bubble growth. There is perhaps a “hint” of such a change (see Table 1), but at this time cannot be certain because the stochastic nature of bubble nucleation and growth.

Comment 7: Page 795, line 22. It’s interesting that the experimental VSD’s at high vesicularities are similar to those in the natural scoria, given the 10x to 100x differences in VND’s (Table 1).

Reply: We agree that it is interesting and interpret this as evidence of the underlying power-law (scale-free) nature of the processes responsible for the bubble size distributions.

Comment 8: p. 798, line 13-14, “The similar power law exponents . . . suggest the operation of similar mechanisms in the magma reservoirs and/or conduits.” Can you be more specific than “similar mechanisms”. Mangan and Cashman for example inferred that similar bubble number densities corresponded to similar decompression rates in the conduit.

Reply: This is the introductory sentence to the paragraph that discusses those “similar mechanisms”.

Comment 9: p. 799, lines 17-19. “We interpret VSDs in the scoriae . . . to reflect gas-melt withdrawal from an open-conduit shallow reservoir steadily supplied with deeper magma.” How did the gas/melt withdraw if magma was being resupplied? Did it withdraw upwards?

Reply: In this case we mean withdrawal by eruption and have added the words “by eruption” immediately following the words “withdrawal”.

Interactive comment on Solid Earth Discuss., 5, 789, 2013.

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