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Solid Earth Discussions

Interactive comment on "Eruptive shearing of tube pumice: pure and simple" *by* D. B. Dingwell et al.

Anonymous Referee #2

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The main focus of this paper is using tomography data on bubbles in tube pumice to assess the shear regime of magma leading up to fragmentation. This is a worthwhile topic and a good approach to address it. However, because there are results/methods/reasoning insufficiently explained, I am unable to assess whether the some of the conclusions are warranted. It may be that only minor revisions are required but I cannot tell without seeing them.

1. Introduction: It isn't clear what is "enigmatic" about the thin bubble walls of tube pumice. (Be more explicit in your reasoning). Also, non-tube pumice often have very thin glass bubble walls - is that enigmatic too or is there something about tube pumice in particular?

I do not understand what you have in mind to cause acceleration of magma in a Plinian eruption if not bubble growth. So I don't understand: "For instance, pure shear may be

favoured in a regime where the strain induced by magma ascent acceleration exceeds the bubble growth rate associated by volatile exsolution".

Section 2.

"The porosity of the undeformed pumice has been estimated at 49–64 %, whereas the tube pumice reach 63–78 % (Marti et al., 1999). . . .Up to 40 % of the tube pumice exhibit localised kink bands, or box folds. . ." I found this text confusing: at first it led me to think that that there are pumice clasts that are not tube pumice. You refer to "undeformed pumice. . . whereas the tube pumice" suggesting that "underformed pumice" are not tube pumice. (Note that you introduce that some pumice have kink bands AFTER writing about "undeformed" pumice.)

How do you know that the sample is "highly representative"? Perhaps make a less bold statement (or else back it up!).

I don't think there is an indication of the size of the pumice clast for which the bubbles have been studied in detail. Is the clast photographed in Fig. 2 the one studied here in detail?

Section 3. "glass shards require minimal sample preparation" What was the sample preparation? Was any polishing done? Presumably, polishing was needed where the there was intersection with a second bubble wall, in order to make the maps of Fig 3 (otherwise would need to correct for thickness variations).

Explain further the reasoning for "we infer significantly higher water contents tha[n] this minimum estimate during the shearing flow described here". What water content is used for the melt viscosity calculation later? The "minimum" value or some value that is significantly higher?

Section 4. "and potentially further aspects of bubble–bubble interactions may ensue at high vesicularities, we see in these samples no evidence of the latter. " The non-elliptical cross-sections of the bubbles look to be evidence of bubble-bubble interactions (deformation related to pushing against each other as they expand).

I'm confused by the calculations. (e.g. I do not follow how Ca is calculated based on " The integration of Eq. (2) through (7) provides us with the capillary number of bubbly magmas".) This is the core of the paper and so the steps must be explained clearly. In doing so, I suggest separating the explanation (and equations) for pre-fragmentation analysis before explaining the post-fragmentation analysis. If I have corrected deduced what was done, then to solve for shear rate (for which a value is reported in figure caption of Fig 9) then you needed to know the melt viscosity which required an estimate of the water content. What value was used for w? However, apparently there was fitting for w: "The results of that fitting yield water contents consistent with the discussion above." Please be more specific - what were the water content values resulting from fitting? The figure 9 caption says "The best fit for simple shear requires a characteristic cooling rate of $10^{-4.9}$ s^{-1} and a strain rate of 10^{-2} s^{-1}" That sounds like the characteristic cooling rate is a fitting parameter. However, I think it is not, but rather is the value determined from a laboratory experiment. Rephrase for clarity.

Is it feasible that the actual cooling rate could be significantly faster than the laboratory experiment? For example because the natural clast was travelling quickly through air?

It is argued that the range lf bubble shapes for a given bubble volume can be explained by relaxation during cooling. If that were then case I would expect systematic spatial variation in bubble shapes because (for all else equal) the bubbles near the margin of the clast will cool more quickly than those in the middle. With tomography data it should be straightforward to look for spatial variations.

"whereas pure shear required non-physical values of strain rates and an infinitely fast cooling rate in order to fit some of the observations." It would be helpful to indicate what strain rates were found.

I was confused about the angle used to quantify bubble orientation. Theta in Figure 1 is related to the orientation of the the longest axis of the bubble (L), which makes sense.

However, the theta shown in Figure 8 appears to be related to the orientation of B. It is not clear how theta was measured for the data shown in Figure 8. (In the diagram theta is the angle between the B axis of the bubble and a line but I don't know how you know where that line is in the sample). For interpretation of orientation data, it would be useful to plot orientation vs. bubble size (a). The ellipticity data shown have a mode that looks very similar to the cross-section for bubbles in 2D hyperbolic pure shear of Hinch and Acrivos (1979). Even if this correspondence is a co-incidence, it does also highlight that can have non-circular cross-sections in a type of pure shear.

There does not seem to be a consideration of types of pure shear flow: axisymmetric extension vs. hyperbolic flow (e.g. Hinch and Acrivos, 1979). Also one can have a combination of pure and simple shear.

Section 5.

An idea is presented for the origin of kinks in some of the tube pumice. It would be nice try to link this to the fact introduced earlier that kinked pumice are of lower vesicularly than the unkinked tube pumice.

I didn't understand how the following is evident (i.e. what is it based on?): "a shift of the fragmentation level in the magma column to greater depths and higher pressures as has evidently been the case at Ramadas."

Abstract: The work on water content and isotopes is interesting and new: a brief summary of these results should be in the abstract even though not the main focus of the paper.

I don't understand what is meant by: ". . . implies that magma ascent is conditioned by a velocity gradient at the point of origin of tube pumice."

More on figures:

Figure 6 could be combined with Figure 4.

Figure 7 caption. Where does the 7mm3 come from in: “51.2 μm $\times$ 51.2 μm $\times$ 51.2 μm (i.e., about 7 mm3)”?

Interactive comment on Solid Earth Discuss., 7, 3053, 2015.