Dear Dr. Küppers and Dr. Longo

We are pleased to provide you with replies to the comment made on our manuscript entitled “Transient conduit permeability controlled by a shift between compactant shear and dilatant rupture at Unzen volcano (Japan)”. The comments were very good and constructive and raised important inconsistencies which have been addressed and corrected.

Before going any further, we would like to thank you, respectively, for the review and the editorial handling of our article, and for your patience with the delays in the preceding weeks. Three of the leading authors (including myself) are currently in the process of moving from our institution, and three co-authors are no longer in academia, hence it has been challenging to coordinate the response in time. We thank you for the generous extension.

Below you’ll find a detailed response (in green) to the comments (in black). The studies cited to support our responses are all listed in the main text.

Reviewer 2 – Ulrich Küppers – 7 Dec. 2021

The manuscript presents results from field observations as well as textural and analytical investigations of parts of the final spine on the 1990-1995 dome of Unzen volcano, Japan. This study is well suited for SE and I recommend publication after minor corrections. I have one main consideration and several line-by-line comments.

Ulrich Kueppers, Ludwig-Maximilians-Universität (LMU) Munich, Germany

Main comment: The authors repeatedly invoke "repeated phases of increased magma ascent rate (line 44) or "pulsatory ascent" of magma (766) as underlying reason for the observed repeated brittle-ductile transitions. I would like to see more discussion whether this is considered a source or a path problem, i.e. whether magma ascent velocity varied in the first place or if geometrical conditions of the conduit system and/or the dynamic evolution of the magma may have led to the stick-slip-behaviour.

This is a great point of consideration, which we would appreciate contributing to; unfortunately, this aspect of magma dynamics cannot be resolved with the data presented in our study. This would best be addressed using a modelling approach. We anticipate that there are feedbacks between the source and the response, causing non-linearity in ascent rate; so both may likely impact each other at different times. Here, however, we refrained to enter this debate as our data would not support any claim we could make about it, and instead we rely on geophysical measurements made during the eruption, including repetitive seismicity (see Umakoshi et al., 2008 and Lamb et al., 2015 amongst others), which indicate the pulsatory ascent.

Line-by-line:

26: "in shallow volcanic conduits": not only here, right? and what means shallow? I would delete this vague indication of depth

Indeed; we simply added this caveat as here, we can only comment on shallow systems (e.g., <1 km). Our reasoning was that, as magma viscosity would decrease with depth, we anticipate a depth-dependent transition where permeability may be more important in controlling volatile transfer (i.e., at shallow depths where viscosity is high and bubbles cannot freely migrate, so gas percolates) and a deeper region where gas bubbles can freely migrates through the melt (i.e., not requiring permeable pathways to operate); this transition would be magma specific. Yet, we opted to remove this as unnecessary addition.

32-34: please add some values.

We feel the abstracts contains sufficient detail; any more quantities, would detract from the main point. These values can be accessed in the main text.

46: "partially tore the spine core with slight displacement". unclear, please explain

We rephrased to “which partially tore the core of the spine, leaving a slight permanent displacement.”

67-69: no obvious order

This order is pre-set by the Solid Earth template for Endnote. We welcome any further indication for the journal if this should be modified.

352: delete "emplaced"?

Corrected.

396: "under microscopy". better say "under/with a microscope"?

Corrected.

397: please quantify the size of "large vesicles"

We indicated: $\lesssim$ 3 mm

402: can bands "localise"?

Bands are, by definition, localised.

414: "crystal plastic deformation" better change to "plastic crystal deformation"?

We added a dash for clarity as the term is indeed, “crystal-plastic deformation”.

419: "few isolated millimetre-size vesicles". how is this possible in a 1 mm wide band (417)

Good point raised here. We re-examined the thin section and revised the size in the text.

444-445: "The fragments in the gouge are generally densely compacted and the porosity is uniformly distributed,". can you comment on whether the compaction took place before mechanical abrasion (rounding) and are a remnant of an earlier texture or if that happenend during sintering?

The gouge does not show sign of sintering; it is merely, poorly indurated. It is hard to tell at what point materials abraded and compacted; presumably, during shear in the final ~500m of ascent. As this took place, the materials would have likely simultaneously compacted, but that remains speculation. We did not add inference on this in the text to refrain from speculating on it.

527: "via crushing of the pore walls". odd wording, please consider rewording

That is common way to describe the textures that form during cataclasis in rock physics.

567: "shallowing of the ascending spine". consider rewording. during magma ascent, the flow field may change such that a plug is formed but a spine is defined as the surficial (= above the dome surface) expression of magma/lava extruded that doesn't change texturally any longer under the acting stress at a given cooling rate.

Thanks for pointing out this inconsistency; we've rephrased to "during shallowing of the magma plug, which impacted fluid flow during spine eruption."

We hope our replies address your questions and any concerns you may have had about the content presented in this study. We thank you for your continued time and efforts on our manuscript, and look forward to your response in due course.

Best wishes from Liverpool,

Yan Lavallée, on behalf of all authors (10 Feb. 2022)