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Interactive comment on "Failure criteria for porous dome rocks and lavas: a study of Mt. Unzen, Japan" *by* Rebecca Coats et al.

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This paper is potentially an excellent contribution to the experimental literature on natural, complex, multi-component, volcanic rocks. Initially, the authors provide an excellent treatment of the relevant rheological behavior of high-temperature deformation in glassy samples which is followed by a good characterization of representative, pre-experiment cores. The study comprises a substantial number of experiments both at ambient room (20oC) and magmatic temperatures (900oC). The rheological data is of high quality and the experimental conditions and span a reasonable range of deformation rates and timescales. The authors do an excellent job of presenting the results separately from analysis and a thorough job of explaining the major decisions and assumptions they had to make in the process of running the experiments (i.e., how and

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why samples were chosen based on porosity, connected porosity, etc., detail on how experimental charges were loaded and the effect that has on the experiment). The rheological analysis is solid and prima facie, the interpretations seem sound and lead to a number of logical conclusions about the behavior of these multicomponent systems under conditions relevant to Unzen eruptions. However, I see one main oversight in their otherwise detailed and robust analysis; there are no descriptions, photos, or representative images and quantitative measurements (porosity, density) of experimental run products. This is a major issue for several reasons: a) Deformation in experimental charges can not be interpreted by using the rheological data alone. For example, seemingly "viscous" behavior and "brittle" behavior were interpreted (starting is section 4.1) based on the "mechanical responses" of the rocks. The authors make assumptions and "attributions" about the actual mechanical behavior of the samples with no empirical evidence. For example they "attribute to a narrowing of pre-existing cracks" and "hypothesize may reflect a contribution of viscous deformation upon loading". It is possible that these interpretations are correct, however, it would be relatively easy to test the attributions and hypotheses by halting an experiment at the requisite place on the deformation path and doing microstructural analysis. b) Post experiment analysis of end products can lead to surprising conclusions about mechanical behavior. In these multicomponent systems, deformation can occur via several mechanisms. Bubble collapse, brittle fracturing, viscous flow of groundmass glass, microcracking, rotation of grains, grain boundary sliding, internal grain deformation. All of these are factors in accommodating strain in the samples. Hence, strain can be accommodated homogenously (throughout the sample evenly) or it can be localized into bands or disparate parts of the sample. Without post experiment analysis, these important rheological behaviors cannot be determined. The authors are making the most logical conclusions about their "brittle" and "viscous" determinations based on the rheological data, however, without visual analysis of bulk properties and microstructures, the authors cannot confirm behavior. In addition, they are losing a considerable amount of important information about the nature of the deformation. c) Post experiment analysis of physical

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properties (i.e., density, porosity) can yield important information on the nature of deformation. Certainly, for the cores that were not destroyed during brittle failure, the authors can make density and porosity determinations via the methods they used on the pre-experiment cores. Bulging of cores may cause a little consternation, however, established methods exist in the volcanology literature to measure density and porosity on irregular samples. d) Characterizing the amount of strain in the samples is an independent measure of machine strain. Does the sample show the same amount of strain as the machine? This can be determined through post-experiment analysis of density, porosity and core geometry. It is an important check on the experimental apparatus to ensure all strain from the machine is going into the sample. Quane and Russell, 2005 (cited by authors) and Quane et al., 2004 from American Mineralogist go through these procedures in detail.

Without post-experiment characterization (on samples that will allow it-sometimes even brittle deformation samples can be salvaged and epoxyed), the authors cannot speak with authority on the types of deformation occurring. Unfortunately, by not having that authority, the Conclusions they draw come into question. Certainly, the authors can do an analysis of the run products and produce a figure or two (like Figure 3 does for pre-experiment cores) to describe the major mechanisms of deformation and strain accommodation. Without this, this otherwise very strong, methodical and detailed contribution falls incomplete.

Technical corrections in this manuscript a very minimum. Found one spelling mistake, but I lost it!

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