

Review of « **Hierarchical creep cavity formation in an ultramylonite and implications for phase mixing** » by James Gilgannon, Florian Fuisseis, Luca Menegon, Klaus Regenauer-Lieb and Jim Buckman

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Dear editors and authors,

This study provides detailed documentation of the distribution of micro-cavities in a quartzo-feldspathic ultramylonite from the Redbank Shear zone (Australia). Based on interesting observations, the authors highlight different processes of creep cavitation that may account for strain-induced phase mixing in natural rocks, which is a *sine qua non* condition to highly reduce grain size and promote intense strain localization. I found the paper very well written, up-to-date and focusing on processes that need to be properly understood regarding their fundamental implications. Although some parts of the manuscript need to be completed and reorganized, the results are convincing and the discussion is coherent, giving rise to a significant advance in this field of research. I therefore strongly recommend this paper to be published, provided that my comments/concerns below are addressed by the authors.

With my Best Regards

Jacques Précigout

Detailed comments/concerns:

Page 1-abstract: The object and techniques used have to be summarized in the abstract. In its present form, we have no idea of what the authors did.

Page 1-Line 1: Spelling « quartzo-feldspathic »

P1-L14: spelling « conditions »

P3-L20: spelling « sample's foliation »

P3-L27: More information about the thicknesses of carbon coating have to be given here. Actually, in an ideal case, it is not recommended to use carbon coating for EBSD analyzes, but sometimes, it is better to add a few nanometers to avoid « charging » effect. So what thickness did you put on your sample block ?

P5-L10: Please add the reference of Bachmann et al. (2010) for MTEX

P5-L11: Some precisions are here required concerning the minimum number of indexed points per grain. Is that in one row, several rows or for the whole grain? We commonly use a minimum threshold of 5 consecutive pixels in several rows.

P8-L1: I would add a comma after « domains »

P9-L1: The figure 6d is called before figure 6b. Please, make sure that the figures are properly called in the manuscript (in successive order).

P10-L23: The figure 9a is not called anywhere.

P11-L20: Please add the reference of Kassner and Hayes (2003) after « dislocations ».

P12-L13: « Kilian et al. (2011) has... » and not « (Kilian et al., 2011) has... ».

P13-L9: Place « secondary minerals are generally absent » before « in the monomineralic... », and not after.

P13-L24: Spelling « identify »

P13-L25: add a comma after « results ».

P13-L29: It would be interesting to discuss our paper here (Précigout et al., 2017, Nature communications), which deals with the relationships between creep cavitation and phase nucleation in ultramylonites. The authors also have to discuss the recent paper of Cross and Skemer (2017, JGR solid Earth). Moreover, I have a question about your sentence claiming that fluid-filled cavities remain unfilled: if phase nucleation does not arise from creep cavitation, how do you explain the transition from GSI to GSS creep by phase mixing? In our paper in 2016 (Précigout and Stünitz, 2016), we do not claim that phase nucleation necessarily follows cavitation. We just say that phase nucleation is fast enough to maintain grain size small and randomize the olivine fabric. Some cavities may remain unfilled, particularly if the fluid is undersaturated.

P14-L11: add a comma after « sample ».

P15-L4: Spelling « known »

Figure 1: Giving the GPS point is not enough, the authors have to provide a simplified map of Australia that locates the sample area. I would also recommend to add a picture of the outcrop. The figure 1C is not located. The figure 1B is not labelled.

Figure 2 (caption): I think it is « figure 2e and f », not « figure 2e and d ».

Figures 6 and 7: these two figures arrive too late in the manuscript. They should appear after figure 1, particularly to show the microstructural features of pores. The text will have to be changed accordingly. By the way, the figure 1C has to be shown with figure 6. The figure 7 also demonstrates that the authors documents 3D features coeval with rock deformation. It has to be given before going into details concerning the distribution and shape of micro-cavities.

Figure 6 (caption): please details the sub-figures (a, b, c, etc.). I am not sure that the figure 6e is necessary.

Figure 8: The EBSD maps have to be shown in the manuscript (not in supplementary material), at least to show the sub-grains. I would recommend to show the three of them. Furthermore, the c axes have to be spelled between square brackets (« [0001] ») and the <a> axes are commonly indicated using <11-20>. The pole figure texture is based on, but not the ODF. Please change « ODF » by « texture » (or equivalent). Please provide the Mindex, as well. That will definitely confirm your point about the distribution of misorientation angles. Use « uniform » instead of « random » in the figure legend.