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Solid Earth
Discussions

Interactive comment on "Myrmekite and strain weakening in granitoid mylonites" *by* Alberto Ceccato et al.

Anonymous Referee #1

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General comments This paper described microstructural characteristics of a granodiorite mylonite developed at 420–460 °C during cooling of the Rieserferner pluton (Eastern Alps), and the role of weakening associated with myrmekite development. Based on the results of rheological calculations, the authors found that during mylonitization at 450 °C grain-size-sensitive creep in sheared myrmekite accommodated strain rates several orders of magnitude higher than the model granitoid deforming by dislocation creep, and then contributed significantly to bulk rock weakening during mylonitization. The descriptions of microstructures and textures of feldspars and quartz presented in this paper are robust, and discussion and conclusions are reliable and interesting. This paper contributes to understand deformation process/mechanism of the mid-upper continental (felsic) crust. In this paper, there are so many supplementary fig-

ures. These figures frequently referred in the main text, and then it is complicated and disturbs our understanding the manuscript. Some supplementary figures should be appeared as figures in the manuscript. The order of figures is somewhat strange. The results of image analysis of grain size and shape (Figs. 6 and 7) should be appeared prior to the the results of phase spatial distribution analysis (Fig. 5). Descriptions of the rheological calculations (section 6.3) are little bit complicated, and then they are not easy to understand. I would like the authors to rewrite and reorganize some sentences in the section 6.3. Although the authors described that micro-cataclastic process or micro-fracturing is a dominant grain size reduction mechanism of plagioclase in the samples analyzed here, the microstructural observations indicative of the micro-cataclastic process or micro-fracturing of plagioclase are not described sufficiently.

Specific comments (1) P4, L2–4: In Fig. 2a, there is no identification of myrmekite and K-feldspar for the ultramylonite. Please identify them in Fig. 2a. In Fig. 2b, there are two red bars for the ultramylonite. Is this correct? If so, what do the two different bars represent? (2) P4, L16–17: What is "monocrystalline structure"? This means plagioclase is a single grain? Please clarify the structural characteristics of plagioclase within in each lobe. (3) P4, L25–26: The quartz vermicules do not show any obvious CPO (Fig. 3d). (4) P4, L29: I do not know why "However". Please remove the word. (5) P5, L7: Please define "AR" (6) P5, L15: At least for me, some plagioclase grains in Area B in Fig. 4a is elongated with the aspect ratio of >2. I would like to see the histogram for aspect ratio of plagioclase grains. Related topic also appears in P9, L2. (7) P5, L18; What does "in crystal direction" mean? It means "in the crystal coordinate system"? If so, please rephrase it. (8) P5, L19–20: two weak peaks? two strong (or distinct) peaks! (9) P6, L12–15: If the pole figure of c-axis shows maxima close to Y kinematic direction, the quartz fabric pattern could be assigned to Type-II crossed gridle or single girdle with Y-point maxima. However, the authors described that the quartz fabric pattern was assigned to Type-I crossed girdle (P6, L13). (10) P8, L18–21: In this sentence, it has been described that grain size refinement of plagioclase involves micro-fracturing as suggested by misorientation analysis on the few low and

high misorientation angle boundaries and CPO randomization. However, the authors have not discussed the mechanism of grain size refinement of plagioclase, based on their own microstructural observations. The following paper may be helpful to discuss this issue: Okudaira, T., Shigematsu, N., Harigane, Y. and Yoshida, K. (2017) Journal of Structural Geology, 95, 171–187. (11) P8, L32–P9, L1: Kruse et al. (2001) and Miranda et al. (2016) suggested very limited deformation by dislocation creep for plagioclase aggregates in mylonites. As far as I know, Okudaira and Shigematsu (2012, Journal of Geophysical Research, 117, B03210, doi:10.1029/2011.JB008799) only described very limited deformation by dislocation creep for quartz aggregates in natural mylonites. (12) P9, L20: "... do not show any microstructure" may be "... do not show any deformation microstructure". (13) P10, L9–11: How about the effect of annealing during and or after deformation? The quartz grains associated with myrmekite may be annealed, and then some of quartz grains in monomineralic quartz layer may be also annealed at least partially. (14) P11, L2: fh is water fugacity coefficient, not water fugacity itself? What is water fugacity coefficient? (15) P14, L2: Why would the composition of plagioclase be assumed to be An100, instead of An60? I do not understand the effect of the plagioclase composition. (16) Equations (23), (24) and (25): What does the superscript of 1 mean? Please describe them. (17) P14, L14: In this figure, the result of diffusion creep for quartz is not necessary. (18) P14, L18–20: I cannot understand this sentence and Fig. 8c. This sentence means a mixture of plagioclase and quartz (i.e., ideal granitoid rock) deformed by dislocation creep. The other curves in Fig. 8c are necessary? It is very confusing. Quartz and plagioclase are deformed by diffusion creep? The calculation scheme for myrmekite is similar to those for Fig. 8b? (19) P18, L9: What is the observation indicative of micro-cataclastic process or micro-fracturing as a dominant grain size reduction mechanism of plagioclase in your samples. Please see also my comment (10).

Technical corrections (1) P3, L11: Ceccato (2018) is missed in the reference list. (2) P6, L24: "Figs. 6f and SOM5" should be "Figs. 6d and SOM5".

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