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

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Response to Elena A. Miranda comments (Referee #2 - se-2018-70-RC2)

1) The methods

"Regarding the methods: the methods (at least the basics) should be in the main body of the manuscript and not in the supplementary material. As written, there are not any methods in the main body. Some of the post-processing details for EBSD can stay in the supplementary material, but the instruments, working conditions, etc., need to be in the main text." Response: We have moved part of the methods (acquisition of EBSD, CL and EMPA data) to the main text, and left the post-processing details for EBSD and image analysis in the Appendix.

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2) The figures

Regarding the figures: there is a tendency for important and primary EBSD data to be relegated to supplementary figures. [. . .] I recommend moving the supplementary figure EBSD maps out of the appendix, and incorporating them into the main set of figures within the manuscript." Response: See our reply to a similar comment raised by the anonymous reviewer#1.

3) Separation of data/interpretation ". . . there are a number of interpretive statements located in the geologic setting and in the data sections;"

Response: we have accepted all the suggestions by the reviewer and modified the text accordingly.

4) Flow law derivation: ". . . whereas the flow law derivation in the main body of the manuscript is extremely detailed, and much of it can be moved to the supplementary material for readers who wish to follow it in more detail."

Response: The detailed description of rheological calculation has been moved to the supplementary material. Specific Comments

(1) Abstract P1, L11: "Rephrase for clarity of reading: Here we use EBSD to investigate the microstructure of a granodiorite mylonite. . .":

Response: Sentence rephrased accordingly.

(2) P2, L11: Is it important to focus the end of the sentence on weakening of coarse-grained pegmatite? It seems like a distraction given that the focus of the paper is not on pegmatites. It may be best to remove this last phrase so that the sentence is more focused on replacement being a weakening mechanism during ductile deformation, which will provide much more continuity with the next sentence about deformation and shearing of myrmekite.

Response: The sentence has been rephrased deleting the last part and including the

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citations preceding brackets.

(3) P2, L14: There needs to be a stronger link between the sentence that ends with the Viegas et al. reference and the next one that starts with 'Fine grain size'. This should be done with the second sentence (i.e., 'Fine grain size. . .) so that the weak plag + qtz aggregate is explained as a result of phase mixing and ultramylonites. As written, it does not explicitly link phase mixing and ultramylonites to the samples targeted in this study.

Response: The sentence has been rewritten in general terms, so that it doesn't need to target our specific sample. However, "the weak plag + qtz" aggregates are not the result of phase mixing in ultramylonites. What we want to show here is different: grain size reduction and phase mixing DUE TO myrmekite formation lead to ultramylonite development.

(4) P2, L16: Rephrase sentence to make it easier to read: Though the key role of myrmekite in strain localization has been recognized, it has not been accompanied with a quantitative analysis, etc. . .

Response: Sentence rephrased accordingly.

(5) P2, L18: The Introduction should be broken up into at least two paragraphs. Make a new paragraph starting with the sentence: 'Here we present the detailed analysis. . .' so that the objectives of the work are clearly separated from the background and disciplinary context.

Response: Paragraph modified accordingly.

(6) P2, L18-20: The sentence beginning with 'Here we present. . .' is awkwardly written, and needs to do a better job summarizing the findings of the work. As written, I am not sure if the authors wish to emphasize the two-fold nature of the work (e.g., 1) analysis of myrmekite evolution and 2) grain size reduction and strain localization), or if they mean to portray this as the temporal evolution of some process, i.e., starting with myrmekite

evolution and finishing with strain localization in the mylonites. The problem hinges on the part of the sentence between the words ‘quartz’ and ‘grain size’. There either needs to be a conjunction word between ‘quartz’ and ‘grain size’ (to? and?) because it’s not grammatically correct as written. This is why it is difficult to understand whether ‘grain size reduction’ just applies to quartz, or to both quartz and plagioclase, and calls into question the intent of the authors.

Response: The paragraph has been modified accordingly to highlight the two-fold aim of the work.

(7) P2, L21-23: These sentences are confusing as written, making it hard to understand which mylonites are being studied. If the shear zones nucleate along joints filled with quartz and epidote, where is the K-spar coming from? Are there two types of shear zones, one set of SZs within the granodiorite and the other set in the quartz- and epidote-filled joints? Does one grade laterally into the other? Please revise for clarity.

Response: The shear zones in the Rieserferner pluton nucleated on precursor joints and on quartz- and epidote- veins. As described in the referenced papers (Ceccato et al., 2017; Ceccato and Pennacchioni, 2018), homogeneous shear zones developed within quartz veins, whereas heterogeneous shear zones developed in the host rock at the immediate vicinity to joints and epidote-veins. K-feldspar is not included in the mineral assemblage of any of the veins, whereas it forms part of the original magmatic assemblage of tonalite and granodiorite of the Rieserferner pluton. The sentence has been modified to clarify these aspects.

(8) P3, L5: I recommend you remove the word ‘precursor’. It is implied that the joints are precursory by saying shear zones exploited them.

Response: Deleted.

(9) P3. Section 3: Sample description and microstructure. The writing in this section is a little disjointed, with abrupt changes between sentences. Some better linkage

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between sentences to provide a smoother train of thought would be helpful.

Response: The section has been splitted into two separate chapters (3. Methods and 4. Microstructures). Details of the analytical techniques have been added to the section.

(10) P3, L6-9: The sentence beginning with 'Nucleation. . .' is effectively a comparison of the field descriptions with what has been documented in the literature for other locations. Such a comparative statement is best left to the discussion rather than in a section devoted to field description.

Response: Paragraph deleted.

(11) P3, L13: I think this section is a little incomplete. There is only a statement describing the shear zones for epidote-filled joints, but the authors state in the previous section that there are also quartz-filled joints upon which shear zones nucleate and also regular joints (no filling) that serve as precursors to shear zones. I recommend that the authors add field descriptions of the shear zones associated with quartz-filled joints and "plain" joints.

Response: Paragraph has been modified accordingly.

(12) P3, L15-16: Rearrange the sentence and break into two sentences for clarity: Polished thin sections of granodiorite mylonite were prepared for the study of microstructure and of crystallographic preferred orientation (CPO). The rock chips were cut parallel to the lineation and perpendicular to the shear plane (XZ plane of finite strain ellipsoid).

Response: Paragraph modified accordingly.

(13) P3, L18: Specify which minerals were analyzed by microprobe.

Response: K-feldspar, Plagioclase. Paragraph modified accordingly.

(14) P3, L20: The description of EBSD and electron microprobe methods and analytical

conditions must be reported in the main body of the manuscript, not hidden in the Appendix.

Response: See our reply to the main comment 1).

(15) P3, L22: The sentence beginning with 'The magmatic plagioclase' is awkwardly written, too long, and hard to understand. It reads like the oscillatory zoning has a range in composition rather than the plagioclase having a range in composition.

Response: Sentence rephrased accordingly.

(16) P3, L24-28: The sentence beginning with 'Various grain size reduction...' is phrased in an interpretive rather than descriptive way. Please rephrase in terms of objective description to be consistent with the "Sample description and microstructure" section title.

Response: This is just a list of the different grain size reduction mechanisms identified looking at Rieserferner mylonite under optical microscopy. We prefer to leave this sentence, as it simply describes the observed microstructures.

(17) P4, L2: There is too abrupt of a change when the data from Figure 2 are introduced. This should be another paragraph, or at least have some more explanatory text about the volume percentage data before it is introduced. Page 4, Line 7-8.

Response: The paragraph has been separated from the preceding text.

(18) P4, L7-8: Why isn't there a photo of the ultramylonites included in Figure 1? All the rest of the mylonites described in this section have a corresponding picture, so this would be good to include for sake of completeness.

Response: As ultramylonites are not described and discussed further in the paper, we prefer to not introduce another figure.

(19) P4, L10: This section is under-developed. These sentences read like a table of contents rather than a data section. It should either be fleshed out into paragraphs

where the data are explained, or this brief summary of figure content should be merged into the text in Section 4.1 onward.

Response: Section deleted.

(20) P4, L17: Figure 7a is called out before Figures 3, 4, 5 have even been introduced. The figures should either be renumbered so that the call outs are in numerical order, or these out-of-order callouts should be removed. There is another error of this nature in Line 18 with respect to Figure 6a.

Response: Figure ordering and callout in the text have been modified.

(21) P5, L1: This sentence is strongly interpretive for a data section. It interprets the origin of the sheared myrmekite, but I suggest keeping the sample/microstructure description objective here and to wait for the Discussion to make the interpretation.

Response: We prefer to keep the terminology as it is, to underline from the beginning the strong link between plagioclase + quartz aggregates and myrmekite.

(22) P5, L9: The callout refers to figure 6e, but there is no 6e (only a-d).

Response: Corrected.

(23) P5, L6: I find the figure callouts hard to follow here. We are flipping between Figure 4 and 6, without 5 being called out yet. Perhaps rearrange the figure order to keep it more organized.

Response: Figure ordering and callout in the text have been modified.

(24) Section 4.3. The paragraphs in this section are lacking strong topic sentences to lead the paragraphs, so that the data are a bit hard to follow. Revise such that a topic sentence gives a summary of the contents of the remainder of the paragraph so that the reader has an idea of what trends are being described.

Response: Two topic sentences have been added to the beginning of each paragraph

to clarify the content of the paragraphs themselves.

(25) P5, L28: Only (100) and (010) are planes. The [001] data are directional and should be described as such.

Response: The sentence has been modified clarifying which numbers refers to planes and which to crystal directions.

(26) P7, L6: “Phase spatial distribution. . .” This sentence is interpretive and the importance of that interpretation is discussed in the next few sentences. I agree this is important, but the interpretation and its importance in a disciplinary context should be in the discussion rather than in the data section.

Response: The paragraph have been moved to discussions and in part deleted

(27) P10, L15-18: Are these differential stresses calculated from grain size piezometry? How are the strain rates calculated? The delivery of the stress values and strain rates is not thorough enough here; if grain size piezometry is an analysis taken on in the work, it needs to be explicitly stated.

Response: Yes, the estimates of differential stress were derived using the recrystallized grain size paleopiezometry (Stipp and Tullis 2003 and Cross et al. 2017). We have rephrased the last sentences of that chapter to clarify that those estimates were derived from the grain size distribution of the quartz domains analysed in this study.

(28) P10, L24: There is something grammatically incorrect about this sentence; revise to clarify what is meant by the last phrase.

Response: Sentence deleted.

(29) P10, Section 6.3: In the interest of brevity, it might work well to put some of the flow law derivations and calculations into the supplemental online material.

Response: The detailed description of rheological calculation has been moved to the supplementary material. However, for the sake of clarity, we have maintained a short

introduction to the rheological calculation, describing the flow laws adopted for each phase.

(30) P11, L11: It is worth noting here that this is a wet plagioclase flow law, and it would be good to quote the amount of water present in these experiments.

Response: Yes, we agree. Sentence modified accordingly.

(31) P15, L5-6: There needs to be a stronger topic sentence than the one that begins Section 6.3.1. As written, it's essentially just a callout to Figure 8, but a more powerful topic sentence would give better direction to the paragraph. The sentence should instead focus on the primary results of the deformation mechanism maps.

Response: The sentence has been modified in: "The grain-size vs. differential stress and differential stress vs. strain rate diagrams in Fig. 8 suggest the occurrence of different rheological behaviour that can be interpreted in terms of strain partitioning between aggregates with different "compositions".

(32) P15, L26: The authors state that they consider both constant stress and constant strain rate conditions, but are there any geologic data from the mylonites that support these assumptions about constant stress/strain rate? This should be justified or explained in a little more detail.

Response: Constant strain rate/stress conditions are two end-member conditions that are considered as hypothetical conditions during deformation and the consequences of such conditions are then analysed in the text.

We accepted all the technical corrections suggested, and modified the text and figures accordingly. Figure 1: Figure 1a: Label the minerals with the abbreviations qtz, bt, etc., to support the caption and to match Figure 1b. Response: Done. Figure 1c: label the myrmekite directly on the figure. Response: Done. Figure 1d: the caption refers to K-spar, but only plagioclase is identified here. Is this the correct figure? Response: Labels for Kfs have been added. Figure 1f: why is the note about CL image after EBSD

scan included? There is no EBSD map area labelled here, so it's hard to understand where in the figure the reader is supposed to look for this. Furthermore, is this an important and necessary point to include? Consider deleting if it's not central to the story. Response: The EBSD map area has now been identified by a dashed white line. It is important to highlight this fact because EBSD scans modify the CL signal for quartz and a possible reader might get confused looking at the CL image. Figures SOM1-5. These figures are commonly called out in the text and contain important primary data, so they need to be in the main text with the rest of the figures rather than in supplementary materials. These maps are more insightful on process than just the phase maps in the standard figures, so this is an important change to make. Response: See response to major comment.

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