Dear Editor,

At your request I have reviewed the rheological aspects of the discussion in the contribution of Ceccato et al. (2018), titled 'Myrmekite and strain weakening in granitoid mylonites'.

Ceccato et al. provide a robust observational basis from which to explore the rheology of a granitoid rock that has undergone microstructural change by myrmekite formation. The authors use a combination of analytical and empirical rheological equations to make statements about the changes in strength of their samples and strain partitioning during creep.

Specifically, Ceccato et al. compare:

(1) a hypothetical granitoid rheology (which is grain size insensitive (GSI) and analytically derived);
(2) the rheology of pure quartz layers (for both grain size sensitive (GSS) and GSI creep);
(3) and the rheology of sheared myrmekite, which is calculated from microstructural observations of grain size and phase proportions (again for both GSS and GSI creep).

The authors find that the rheological analysis supports the assumption that the myrmekite, produced sny-kinematically, is weaker than the rest of the mylonite's constitutive parts. The interpreted weakness is then postulated to promote strain partitioning in the mylonite.

General comments:

With the inclusion of the rheological discussion the authors provide the contribution with a rounded perspective. Specifically they advance our understanding by applying the results of laboratory and theoretical works to a natural example. This links the microstructural analysis to the current understanding of the physics of creep. I particularly like the inclusion of the experimental results of Xiao et al. (2002) for comparison. This anchors the analytical rheological equation used for the sheared myrmekite to a comparable phenomenological work. It is also of note that the protolith used for comparison is not assumed to be a mono-mineralic flow law but that the authors construct a poly-mineralic law for a granitoid. I think this makes for a much better comparison and brings us closer towards the complexity of nature. The work is considered and well written and I recommend it for publication.

That being said, I have a few minor comments that may make the work clearer at points for those not expert in rheology.

Best,

James Gilgannon

Specific comments for the Authors:

TEXT

P11, L29:

The contribution of pressure-solution creep in Qtz has been calculated following the flow law for thin-film pressure-solution of den Brok (1998):

Previously it is written that you consider diffusion creep of quartz (P11, L17) and here you talk of pressure solution with no intermediate step in explanation. As there are many diffusion creep models that all have very similar forms it is probably helpful for the reader to have a step from the statement in line L17 to L29. Therefore I would be inclined to reformulate the sentence to something like:

'The contribution of diffusion creep in quartz is considered to come from pressure-solution creep and has been calculated using the flow law for thin-film pressure-solution of den Brok (1998):'

P12, L6-14:

For feldspar, the flow laws of Rybacki et al. (2006) […] Details on the derivation of the deformation mechanism maps and on the calculation of the flow laws are given in the online supplementary material.

I think here you might want to invert the order: introduce the approach used for defining the poly-mineralic aggregates and then cite the feldspar laws. Something to the effect of:

'The flow laws for poly-mineralic aggregates (e.g. sheared myrmekite and mica-free granitoid) have been calculated following the approach of Dimanov and Dresen (2005) and Platt (2015). The method allows a poly-mineralic aggregate flow law to be constructed by considering the proportional contribution of the minerals in the aggregate. The resulting flow laws for the poly-mineralic aggregates can be derived for both a GSS and GSI rheology and are outlined in detail in the supplementary material. In our calculations only quartz and feldspar are considered as minerals of the aggregates. For quartz the flow laws used are those above (eq. 1 and 2), while for feldspar, the flow laws of Rybacki et al. (2006) have been used to calculate the contribution of dislocation and diffusion creep:

EQUATION 3

where: Af is the pre-exponential factor for feldspar (MPa-n μmm s-1); d is the grain size (μm); m is the grain-size exponent (m=3 for diffusion creep; m=0 for dislocation creep); p is the confining pressure (MPa); Vact is the activation volume (m3 mol-1). Flow law parameters are listed in Table 1. Details on the derivation of the deformation mechanism maps and on the calculation of the flow laws are given in the online supplementary material.'

This is just a rough rearrangement of what you wrote but with an additional couple of statements. I think this makes the flow of this section easier. Otherwise you introduce feldspar as a rheology after you state you will only consider quartz and poly-mineralic aggregates and not pure feldspar. In this order it makes it clearer that feldspar is used as a part of the poly-mineralic calculation.

P14, L9:

observed for a reaction progress factor…

Prior to this there is no mention of the reaction progress factor. I am unsure where this fits in the analysis. In the supplementary material I could access I did not see any mention of this factor. From reading the previously submitted draft, I think since your revisions you have moved the mention of this parameter to the supplementary material. I would recommend that you point to where it can be found in the supplementary material.

EQUATIONS

I would recommend that the strain rates for each mechanism be uniquely labelled with sub/superscripts. The reason for this is that in your rheological calculations the total strain rate is assumed to be equal to the sum of a set of strain rates from those unique mechanisms. Unique labels help make this clearer. For equation 3 that might involve breaking it into two equations: one for dislocation creep and one for diffusion creep.

FIGURE CAPTIONS

Figure caption 9:
I think that the caption for figure 9b needs some smoothing out.

P28, L6:

(b) A and B marked red polygons represent the differential stress range derived from piezometric calculations on pure Qtz layers (red and black stars along respective piezometric curves).

I think that you are referring to what you take as the iso-stress values for the red polygon in fig. 9b but it is not clear because A and B are not present in figure 9b.

FIGURES

Figure 2:

On the version I have there is no scale, however the inclusion of a scale might help the reader.

Figure 9:

Fig 9b)
You have a lot of information in this figure. Currently, I think that the 'black box' is hard to identify because there is also the grey polygon and all of the log-log lines. If you don't wish to break up the figure, you might consider labelling the vertical lines with the corresponding grain sizes or making the 'black box' something else, like a hatched box and making the log-log lines considerably more transparent.

Fig 9c)
Here you plot pure feldspar for An100 and An60 but do not discuss it in the text. I would remove these from the plot. In your discussion you focus on comparing pure quartz, the sheared myrmekite and the mica-free granitoid and do not discuss the role of pure feldspar.