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Interactive comment on "Syn-kinematic hydration reactions, dissolution-precipitation creep and grain boundary sliding in experimentally deformed plagioclase-pyroxene mixtures" *by* Sina Marti et al.

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General comments

This paper describes a series of deformation experiments performed on hydrous mixtures of plagioclase and pyroxene, designed to investigate the influence of syn-kinematic reaction on the strength and deformation mechanisms of lower crustal rocks. Through detailed microanalysis, the authors conclude that reaction-driven grain size reduction enhanced dissolution-precipitation creep, leading to strain localization. Overall, this is an important and well-executed piece of work. However, I would like the authors to more thoroughly discuss the evolution of porosity through the experiments. The

starting materials (powders) were hot-pressed in-situ during the PT ramp and run-in. No details are given regarding the porosity of the starting material, and it is possible that significant reaction took place before deformation began, while the samples were not fully densified. Observations of porosity/dilation in the deformed samples imply differential stresses in excess of the confining pressure (1-1.5 GPa), which are not supported by the mechanical data. Nevertheless, with some clarification, this has the potential to be a valuable contribution. The writing and figures are generally of excellent quality, although a few minor clarifications are needed, as detailed below.

Specific comments/corrections

- Line 16 – need to be careful when talking about diffusion creep and grain boundary sliding as separate mechanisms. Grain boundary sliding always occurs during diffusion creep, as an accommodation mechanism for changing grain shapes (see Raj & Ashby, 1971; Gifkins, 1976). - Lines 20-21 – references needed for "It is often suggested that viscous deformation in monomineralic aggregates at mid- to lower crustal conditions is dominated by dislocation creep" - Line 29 – comma needed after "differential stress" - Line 47 – worth pointing out here that, in the absence of fluids/reaction, phase mixing is extremely inefficient (e.g., Linckens et al., 2014; Cross & Skemer, 2017). Thus, strain may preferentially localize into wet/reactive portions of the lithosphere (this is also supported by the experiments performed here, showing extensive phase mixing at low strains). - Line 70 – full-stop/period needs to be removed after "enstatite" - Lines 85-87 – important to mention here that the samples were hot-pressed in-situ at experiment conditions during the run-in to the hit-point. What was the porosity of the starting material at the hit-point in the 1.0 GPa and 1.5 GPa experiments? How much reaction took place during the ramp to PT conditions, and during the run-in to the sample hit-point? - Lines 70-72 – best to add all the abbreviations used here, to match with those given in Table 2 - Line 89 – need to mention that thickness is measured parallel to the shear plane normal - Lines 95-96 – this needs a bit of re-wording. γa will underestimate shear strain in localized zones, and overestimate shear strain in undeformed/low-strain zones. - Line 99 – “strain ratio” instead of “strain ration” - Line 129 – use of the word “near” here is a bit subjective. None of the samples exceed 50-60% of the Goetze criterion. It’s probably sufficient to say that none of the samples exceeded the Goetze criterion, so brittle/dilational behavior is not anticipated (presence of open pores contradicts this, however – see below). - Section 3.2 – if phase/element maps are available (like those in Figure 13), these would be preferable for showing the reactions (it’s difficult to tell all the phases apart on the BSE images in Figure 5) - Line 204 – I think this should be “intragranular” instead of “intergranular” - Line 207 – the presence of pores contradicts an earlier statement about the Goetze criterion not being exceeded, unless large local stresses along grain boundaries were sustained through the experiments. Alternatively, the opening sites shown in Figure 9 (particularly 9e, for example) could have formed during decompression. - Section 3.4.3 – given the low symmetry of plagioclase (and large number of documented slip planes/directions), it may be more informative to determine slip systems using inverse pole figures – e.g., parallel to the shear direction, perpendicular to shear plane. See Fig. 11 in Miranda et al., 2016, JSG, for example, which shows (011)[-100] as the dominant slip system for intermediate-composition plagioclase (deformed at similar conditions to this study). - Lines 314-315 – I think it’s more a case of host-controlled growth. Grains may nucleate in any orientation, but those with low interfacial energies w.r.t. the host will be the ones to grow. - Lines 320-323 – are you able to say anything about the feasibility of the other CPO-forming mechanisms described here? Do grains have a crystallographically-controlled shape; are there systematic interphase misorientation relationships indicative of host-controlled nucleation/ growth? This would be interesting to add, but may be beyond the scope of the paper. . . - Line 364 – misspelling of “earlier” - Line 373 – G and t need to be defined - Lines 381-389 – I’m not sure what the significance of this paragraph is. Are the authors suggesting that fractures formed in regions of high dislocation densities, leading to enhanced fluid flow and reaction? Again, given that Pc was 2-3 times higher than differential stress, it is difficult to imagine that dilation occurred. - Line 395 – “DPC” instead of “DCP” - Figure 1 caption – use “counterclockwise” instead of CCL

- Figure 5 – it would be useful to point out where the “shear band close-up” images come from in the “overview” images - Figure 5k – the phase map colours are very faint, and are difficult to tell apart

References

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