

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 discusses experiments on deforming pyroxene plagioclase mixtures in the presence of water, a common scenario during metamorphism in the Earth. The work aims to elucidate deformation mechanisms when there are ongoing reactions, by means of mechanical and microstructural observations. The work is of good quality and in general the conclusions are justified but the paper would benefit from some “scene setting”. It is not always obvious in advance why various measurements were made, although the interpretations are interesting afterwards. For example coronas

C1

have thickness anisotropy but was that a particular focus of the work, and were there hypotheses to be tested prior to the observations? In terms of results, a bit more discussion would be beneficial. For example two stress exponents, n , are obtained using constant strain rate data and strain rate stepping experiments, but it is not explained why they are different. The observations on porosity are interesting – it is difficult to envisage open pores at 1.5 GPa, but there they are. Is there a chance they formed on sample unloading? The initial powders were highly porous presumably. I can't tell if they were more or less fully compacted prior to deformation. Other points are made below.

Specific comments

1. Abstract first line is vague – what exactly is poorly constrained?

37. diffusion creep always involves GBS; see also 6, 288, and Raj and Ashby (1971) p. 1120. Title: “Syn-kinematic hydration reactions, dissolution-precipitation creep and grain boundary sliding in experimentally deformed plagioclase-pyroxene mixtures” does not really need reference to GBS as it is implicit. 43. “diffusion is expected to be faster along phase boundaries compared to grain boundaries”. Wheeler (1992) does not say this, instead he shows that coupled diffusion and reaction may enhance strain along heterophase boundaries even if diffusion coefficients are the same as along single phase boundaries. I think that work has been misquoted previously. I do not know if the other cited works are explicit that diffusion is expected to be faster along phase boundaries compared to grain boundaries. 55, 60. Aims vague 95. overestimates – how? 105. Corona thickness is an interesting property – but, to be clear, why was it measured? What hypothesis was being tested? 107. “separated manually” needs further explanation. 133. “Strain rate stepping tests” – why, what is their role? 141. Reaction R1 is not easily balanced, and will be different for Opx and Cpx. Any comments? 178. “increased amount of reaction products at higher P_c ”. Any idea why? 287. Why are stress exponents different? 296. Why does cation ordering affect strength (give reference)? 314. “Furthermore, a CPO can form due to interfacial energy, e.g., via

C2

host-controlled nucleation (e.g., .." (Jiang et al. 2000)). This is a rather confusing phrase. What does "due to" interfacial energy mean? Nucleation rate is certainly influenced by interfacial energy, but surely nucleation is "due to" (in this case) a chemical driving force, namely to change plagioclase to albite. 326. Or could the coronas have been squeezed out somehow? Move line 343 up here to answer. 334. "The geometry of deformation by diffusion creep is irrotational" – please explain. Grains DO rotate during diffusion creep, surely, which is one way it weakens a prior CPO. 399. This seems reasonable but is not entirely logical. Of course finer grain sizes are more prone to DPC but microstructures are always hard to interpret. The best evidence is the low stress exponents. 404. "the chemical driving potential for attaining a lower energy assemblage partially controls the reaction rate". Broadly yes except there is no unique driving force (no Gibbs free energy defined) in a stressed system (Wheeler 2014, 2018) .

Technical corrections

82. Tromso – Tromsø 99. ration – ratio 196. amphibole 260. accompanied by 363. earlier 373. What is t in ΔGt ? Fig 1. What is CCL? Table 1, 3. Poor quality – reformat? Fig. 5k Make colours a bit stronger? Fig 7b) In colour, like others?

Jiang, Z., Prior, D. J. & Wheeler, J. 2000. Albite crystallographic preferred orientation and grain misorientation distribution in a low-grade mylonite: implications for granular flow. *Journal of Structural Geology* 22, 1663-1674. Raj, R. & Ashby, M. F. 1971. On grain boundary sliding and diffusional creep. *Metallurgical Transactions* 2, 1113-1127. Wheeler, J. 1992. The importance of pressure solution and Coble creep in the deformation of polymineralic rocks. *Journal of Geophysical Research* 97, 4579-4586. Wheeler, J. 2014. Dramatic effects of stress on metamorphic reactions. *Geology* 42(8), 647-650. Wheeler, J. 2018. The effects of stress on reactions in the Earth: sometimes rather mean, usually normal, always important. *Journal Of Metamorphic Geology* 36, 439-461.

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