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Interactive comment on "Fracturing and crystal plastic behavior of garnet under seismic stress in the dry lower continental crust (Musgrave Ranges, Central Australia)" *by* Friedrich Hawemann et al.

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Review Fracturing and crystal plastic behavior of garnet under seismic stress in the dry lower continental crust (Musgrave Ranges, Central Australia) Authors Friedrich Hawemann, Neil Mancktelow, Sebastian Wex, Giorgio Pennacchioni, Alfredo Camacho Summary The authors of the manuscript present detailed data on plastic garnet deformation from a medium pressure/medium temperature shear zone from the Musgrave Block in Southern Australia. The investigated felsic samples stem from the Davenport Shear Zone with a strike slip sense of shear and experienced granulite facies metamorphism prior to deformation, which resulted in an intense dehydration of the rocks.

The authors interpret this intense dehydration and the lack of infiltrating fluids during the deformation to be the reason for the rheologically distinct properties of the rocks. These distinct rheological properties involve the crystal-plastic deformation of garnet at temperatures in the order of 600°C. Interestingly, such temperatures are significantly lower than those experimentally determined for crystal-plastic deformation in garnet. The authors therefore draw several conclusions from their observations: (1) the experimental data for crystal plasticity in garnet cannot be transposed to natural conditions, (2) the differential stresses causing the plastic deformation of garnet are high, transient and caused by lower crustal earthquakes.

General comment The manuscript focuses on a geoscientifically relevant and interesting topic, i.e. paleo-earthquake features in deformed rocks and their interpretation with respect to deformation mechanisms and stress quantification. The authors write in concise English and the structure of the manuscript allows the reader to follow the authors' arguments and discussion easily. The topic of the manuscript is up to date and the data presented here is all new. However, I think that some of the interpretations in the authors' discussion are not fully supported by the data. One crucial argument for crystal plasticity in garnet is the observation of dislocation walls that mark the boundary of one subgrain in the garnet crystals. The authors state that these dislocation walls are the result of dislocation climb in the crystal (lines 252-253) and therefore indicate the activity of viscous deformation mechanisms in garnet. I am not entirely convinced that these dislocation walls are only produced by the migration of dislocations through the crystal, although I am not aware of studies that demonstrate neither pro nor contra arguments. The fact that the authors do not cite any references is also not helpful with this regard. However, there is evidence that such dislocation walls can be generated in undeformed rocks, e.g. during fluid infiltration, such as demonstrated in Konrad-Schmolke et al., 2018. Of course, fluid infiltration does not play a role in the rocks presented here, but other mechanisms for the formation of the dislocation walls must be discussed in this manuscript, as these structures are a fundamental argument for crystal plasticity. Furthermore, the interpretation of the presence of rotated subgrains in terms of subgrain rotation recrystallization is, in my opinion, also questionable. Konrad-Schmolke et al., 2007 demonstrate the presence of subgrains in garnets (and their slight misorientations) in undeformed rocks. In general, I think that the manuscript would very much benefit from a more indepth discussion of these features. The papers cited in this review should only serve as examples and I think that there are many other contributions to the topic that I am not aware of at the moment. However, I think the manuscript is very well suitable for publication after moderate revisions and a more thorough discussion.

Specific comments

Line 138: if the fractures a dilatant there must be some material in the cracks. Can that be evaluated?

What about the other, fast diffusing elements, such as Mn and Mg? Differences in diffusion lengths would indicate different diffusion velocities and thus support the idea of a diffusional modification.

Lines 196-197: This diffusional modification is likely due to subgrain boundaries that might or might not be associated with subgrain rotations. This has been demonstrated in Konrad-Schmolke et al., 2007 (EJM). This should be discussed or at least mentioned.

References cited in this review

Konrad-Schmolke, M., O'Brien, P.J. & Heidelbach, F. (2007). Compositional re-equilibration of garnet: the importance of sub-grain boundaries. European Journal of Mineralogy, 19, 4, 431-438. Konrad-Schmolke, M., Halama, R., Wirth, R., Thomen, A., Klitscher, N., Morales, L., Schreiber, A. & Wilke, F. D. (2018). Mineral dissolution and reprecipitation mediated by an amorphous phase. Nature Communications, 9(1), 1637.

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