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Solid Earth Discussions

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.

Anonymous Referee #2

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Summary: The study by Hawemann et al. presents naturally deformed garnet grains that show micro- and nanostructures interpreted as brittle and crystal plastic deformation features. The main point the authors make is that the observed crystal plastic deformation occurred at 'dry' conditions and at around 600 °C contrasting laboratory data showing the onset of plastic flow of garnet at T > 850 °C. The manuscript is very well written and the subject presented is interesting. Therefore, I suggest publication in Solid Earth after moderate revisions.

General comments: The main message of this manuscript is the occurrence of crystal plasticity in garnet at temperatures well below the laboratory derived data for the

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onset of crystal plastic deformation in garnet. The authors, therefore, state that laboratory data fail to explain the natural observations. Of course laboratory experiments are most often very simplified rendering extrapolation to natural systems rather challenging. Though, I miss a bit the explanation why the laboratory data does not match natural observations. Is it because the samples in the laboratory were even drier than the natural rock delaying the onset of crystal plastic deformation in the laboratory? Obviously there were some fluids present due to the occurrence of biotite. Though in some parts of the manuscript, the authors state that a Ca-rich garnet forms instead of epidote, because of the low water activity (line 290). Perhaps there was enough water around to facilitate crystal plastic deformation but not enough to stabilize epidote? I think it would improve the manuscript to discuss the role of fluids on crystal plastic deformation in more detail. This might also explain the discrepancy between laboratory data and the natural observations.

Detailed comments: Line 71: In this context I think crystal plastic deformation instead of ductile deformation is more appropriate. Lines 276-278: Did you investigate/find garnet crystals that were cut by a pseudotachylyte? Both studies that you cite, Austrheim et al. (2017) and Papa et al. (2018), demonstrate garnet crystals that are situated right next to a pseudotachylyte-bearing fault. I mention this, because as strain rate and stresses decrease very rapidly with increasing distance, the required stresses and/or strain rates at a few mm to the fault might not be sufficient anymore to extensively fragment garnet. Line 286: Delete 'of some'. Lines 291-292: So everything is dry, but suddenly there is biotite? You should discuss the presence/absence of hydrous minerals a bit more. Lines 304-305: Shimada et al. (1983) experimentally investigated that the angle changes from around 30 to approx. 45° with increasing pressure. Lines 311-313: See comment above. As water seems important you should perhaps quantify the amount of water? There is some water present in the other field studies mentioned, but not very much. How should the presence of a fluid help to fragment the rock? Figure 5: The difference between fracture types I and II is not very clear to me. The magnification at which the image was taken is quite low and therefore it is difficult to

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see subgrains.

References cited in this review:

Austrheim, H., Dunkel, K.G., Plümper, O., Ildefonse, B., Liu, Y., Jamtveit, B., 2017. Fragmentation of wall rock garnets during deep crustal earthquakes. Sci. Adv. 3, 1–7. doi:10.1126/sciadv.1602067

Papa, S., Pennacchioni, G., Faccenda, M., 2018. Thermal fragmentation of garnet during deep-seated co-seismic frictional heating Thermal fragmentation of garnet during deep-seated co-seismic frictional 46, 471–474.

Shimada, M., Cho, A., Yukutake, H., 1983. Fracture strength of dry silicate rocks at high confining pressures and activity of acoustic emission. Tectonophysics 96, 159–172. doi:10.1016/0040-1951(83)90248-2

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