Solid Earth Discuss.,
https://doi.org/10.5194/se-2017-123-RC2, 2017

Solid Earth
Discussions

Interactive comment on "Pseudotachylyte as field evidence for lower crustal earthquakes during the intracontinental Petermann Orogeny (Musgrave Block, Central Australia)" *by* Friedrich Hawemann et al.

U. Altenberger (Referee)

uwe@geo.uni-potsdam.de

Received and published: 9 December 2017

Comment on "Pseudotachylyte as field evidence for lower crustal earthquakes during the intracontinental Petermann Orogeny (Musgrave Block, Central Australia)" by Friedrich Hawemann et al.

by Prof. Dr. Uwe Altenberger, University of Potsdam, Germany

The article is concentrated on the phenomenon of a multiple brittle-ductile deformation sequence in the Muscrave Block, Australia. The aim of the manuscript is to describe

the fabric and petrology of the brittle event, documented by pseudotachylytes (pst) in detail and to interpret the strong connection of brittle and seismic events. I try to read the manuscript very carefully, because I had worked on deep crustal pst, too and hoped to learn something new. On one hand, there are a lot of interesting observations on different generations oft pst in the Davenport shear zone, on the other hand some descriptions are missing or are too short to evaluate possible results and conclusions. The presented work has to my opinion two strong topics: 1. the proof of deep crustal fault-related frictional melts by petrological methods and 2. the proof of cyclic repetition of brittle and ductile processes. Both topics are managed, but not sufficiently. The manuscript has a loot of weak points, which has to be corrected before publishing. The petrographic observations of the host rocks are little and sometimes not clear but these have strong relation to the conclusion These rocks, especially the contact zone to the pst should be described in more detail. Are there any remnants of previous, possibly ultra-mylonitic, deformations? Are the pst concentrated in special layers of the protolithe, e-.g. involving more (OH) - bearing phases? In the description of the dolerite, as a protolithe, there is no given mineral assemblage (does it include grt or hbl as a (OH)-bearing phase?). Is there any thin-section or SEM image of the mylonites adjacent to the pst (e.g. a prolongation of Fig 4). Is the brittle deformation a direct consequence of the ductile deformation ?, e.g. same layers, or discordant after changing the stress system? The reader is not informed if the minerals described are "magmatic", i.e. crystallized directly from the melt or if these are formed (overprinted) by the crustal metamorphism. In the deep crustal environment this is not easy to distinguish but has a strong impact on the interpretation. We know from some places, that kyanite can crystallize from the melt and, as it is described, the garnet with cauliflower structures are a clear evidence for rapid cooling, i.e. crystallizing directly from the melt. In addition, pyroxenes can form under high-temperature or high-pressure conditions from a melt, or recrystallized later from the very fine-grained to glassy pst matrix. And how can we know, that kyanite is formed in the sample, not sillmanite? They are probably too small to distinguish by the used methods, XRD is need to confirm this, not pseudo-

sections. A point of interest is also: which minerals from the protolithe are consumed and which are stable. I think biotite will directly melt, producing some (OH). Amphibole too. The consumed minerals control the composition and rheological behavior of the melt. The descriptions of some important figures like Fig 4 is too short-and do not describe the four generations of pst sufficiently. Some simple ideas have no base, if it is written, two generations of pst overprinted by ductile deformation are an indicator of cyclic brittle and ductile deformation. It is only an evidence for two phases of brittle deformation followed by ductile deformation. What is the PT-conditions of the ductile deformation-any evidence? Is it possible, that the ductile event is part of the retrograde exhumation? Some parts are clearly described but not well thought: a pst in a gabbro is containing Kfs clasts - gabbros should not contain Kfs. And the matrix is free of plagioclase and composed of Grt+Cpx+Kfs+Qtz? What does this mean? Is the melt travelled a longer distance, from a different protolithe? I agree with the used method of pseudosections. However, is there any further indication for the deep crustal evolution, like high Al2O3 concentration in the newly formed pyroxenes, what is the composition of the melt-derived garnets-there are experimental data on the P-conditions of garnets formed from magmatic melts (given in the cited Altenberger 2011, 2013) In addition, the word recrystallization, which is often used by people from petrology, structural geology as well as from geochemistry; is often used in a different way. Therefore, please write if in the described examples recrystallization is crystallization from the melt (e.g. grt) or recrystallized under metamorphic conditions during later times from the fine-grained matrix? This is important, although not easy to distinguish. We often have the situation that quenched crystals have a metamorphic rim etc. You can calculate by your data also the geothermal gradient - it is only ca 20°/km. So the seismicity has happened in a relatively cold crust.

Although there is no real evidence for cyclicity, there is a well-described evidence of a polyphase evolution. However, I am wondering, that the classical paper of Handy & Bruhn (2004, EPSL,223), thinking about the cyclicity and “Stress– strain evolution for a volume of rock undergoing deformation to frictional sliding or creep at a constant slip

or strain rate” is not cited. The interpretations in the manuscript are not satisfying, but maybe there is no simple answer. Is there any correlation with the drastic change in shear direction from sinsitral to dextral?

I attached some additional corrections to the original manuscript.

To resume: the manuscript is worth to get published. It will submit more data to these deep crustal and not well understood lower crustal processes, although a satisfying interpretation is not given by the authors, yet.

Please also note the supplement to this comment:
https://www.solid-earth-discuss.net/se-2017-123/se-2017-123-RC2-supplement.pdf

---

Interactive comment on Solid Earth Discuss., https://doi.org/10.5194/se-2017-123, 2017.