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Solid Earth
Discussions

Interactive comment on "Constraining metamorphic dome exhumation and fault activity through hydrothermal monazite-(Ce)" *by* Christian A. Bergemann et al.

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General assessment

The manuscript presents and extensive new dataset of cleft monazite ages that are an important addition to exiting geochronological work in the Alps. In addition, the study presents an interesting analysis of the relationship between the duration of tectonic events and the spread in ages recorded in individual monazite crystals. The paper certainly falls within the scope of Solid Earth, but has significant shortcomings in its presentation and therefore I recommend that it undergoes major revision before being accepted for publication in Solid Earth.

The manuscript in its present state has three major shortcomings: 1) The data are presented and grouped in multiple ways that are not always clarified to the reader, which makes it impossible for the reader to judge whether the interpretations are sound. 2) The figure numbers appear to have been switched around several times during the preparation of the manuscript leaving many incorrect references, including a non-existing figure in the electronic supplement, making it nearly impossible to find the correct data. 3) Section 5.3 is not clearly argued and organised and needs to be revised to clarify the reasoning of the authors.

The abstract suggests the results of the study include major new findings, but if fact the results mostly confirm existing age information. To me, the value of the paper is more in the applicability of cleft monazite ages and the different expression of faster and slower tectonic processes in this dataset.

Note: This review was performed after the review of Dr. M. Rahn became available. I have tried to avoid duplication. I agree with most of his comments and suggestions.

Numbers between brackets below (1) are marked in the appended annotated manuscript.

Specific comments (for technical comments and notes in the text, as well as the full review with clearer formatting, please refer to the supplement to this reveiw) Throughout: figure numbers and references to them are a mess throughout the manuscript. This needs thorough checking.

Page 1 âĂć The title is too general and not entirely on-topic. Metamorphic dome is rather unspecific. Please add an indication of location and perhaps time (Alpine). Given that the applicability of the method is not restricted to metamorphic domes, it may be better to rephrase the title altogether.

Page 2 (4) It would be good to add a sentence or two at the end of the introduction that elaborates on the aims of the study. (6) The more generally interested reader may

have no idea where we are. I suggest to move Fig. 2 here and to add a reference to this figure to section 2.1. As indicated by Dr. Rahn, Figs. 1 and 2 need to be completed with coordinates, an indication of North, etc.

Page 3 (10) The samples were grouped “roughly correlating to tectonic subdivisions” is a vague statement and leaves the reader unable to judge the criteria that were applied. This might give an unfortunate impression of arbitrary grouping, which renders the paper less persuasive. (12) Regarding Figs 3 and 4, it would be good to mention briefly in the text, and not only in the figure caption what characteristic causes the zoning and how that is thought to be related to age information.

Page 4 (13) See annotated manuscript for necessary edits to figure 1. The term “Geological-geometric in the caption is unclear. Perhaps best replaced by “Geometry”.

Pages 7 and 8 (15) The images and all lettering in figures 3 and 4 should be enlarged so the reader is better able to assess the placement of the spots. Dr. Rahn mentions justified concerns regarding the placement of spots across boundaries between compositional domains. Some of the spots within one apparent compositional zone have different colours and it is not clear why that is the case (e.g., grains Duro2 and Klem1). The caption mentions “the color of the frame” but it is not entirely clear what that refers to. Is it the box around each weighted mean age result? Please clarify.

Pages 10-12 (18) In addition to Dr Rahn’s comments. Please add spot numbers so the ages can be matched to the spots in figures 3 and 4. Enlarge lettering for readability; 6 pts at full size printing is usually considered minimal. I printed the pdf to A4 and most figures are too small in one way or another. The meaning of grey bands in these figures is not clear to me. Are the colours matched with those in figs 3-4?

Page 12 (19) The content of section 5.1 is more fitting for the introduction than for the discussion.

Page 13 (22) The decisions behind the groupings are not really explained and therefor the reason has no way to judge whether these decisions are sound, or not. In addition, as indicated in figure 3 some spots within the same apparent chemical domain (based on BSE, other compositional data that may have been used is not available to the reader) are marked with different colours and therefore apparently assigned to different groups for reasons not indicated. The groupings need to be argued more clearly to convince the reader. (23) “to calculate, whenever possible, weighted mean domain ages (Fig. 7).” Should this be figure 8? It is unclear to me what determines whether a weighted domain age can be calculate or, in fact, how this is done. This needs more explanation. It seems that some of this explanation is actually in the paragraph following this reference. It would be better to first explain the procedure and then present the calculated ages. (24) “It appears that if dissolution-precipitation may largely preserve the chemical composition of an affected crystal part, this would mean that areas with different chemical compositions may have reprecipitated simultaneously.” What is the basis for the assumption of preservation? Has this been shown in the literature? Or do the data somehow suggest this? This needs to be explained better. For the second part of the sentence, I do not understand the reasoning either. I am not an expert on monazite dating, but if the authors want the reader to trust the validity of their interpretations, they need to argue their assumptions and decisions more clearly. (26) There is no figure in the appendix. Has this figure been moved to the inset of Figure 8? Please correct accordingly.

Page 15 (29) This is certainly not clear from Fig 2 or 7, and perhaps refers to Fig 8. If so, the statement that the age ranges within grains are generally longer in the Eastern and Southern domain does not appear to be supported. This could also refer to figs 5-7 (I now note that the panels are numbered continuously through figures 5-7, which is rather confusing), but there I do not see a consistency in the graphs to support this statement either. This leaves me at a loss as to the basis of this this statement. This needs to be clarified.

Page 16 (31) The shadings in Figure 9 render the ages illegible and this figure needs editing for clarity. It also seems that the age ranges are idealised to an extent: in 9b a 13.6 +/- 0.4 age is included in the 15-14 Ma range and in 9c a 13.4 +/- 0.3 age further West is included in the 13-11 Ma range. The 13-11 Ma area in 9c includes the area coloured in 9b, which contains almost exclusively ages >13 Ma. The colouring is persuasive but the averaged ages do not appear to match the areas all that closely. From the caption it seems that the shaded areas are based on all ages from each sample, but the weighted mean average ages are based on a selection of those. Such, presumably unintentional juggling with the data makes it almost impossible for the reader to judge the value of the results and interpretations, which is very unfortunate. The authors need to do a better job in presenting their results to convince me that their interpretations are valid and can be used to underpin a tectonic scenario.

Page 18 (36) The first sentence of the conclusions is a bit awkward. Please rephrase. (37) “age clusters within individual crystals from a simply exhuming area have a less clear age distribution than samples from fault zone areas, or fast exhuming areas.” This apparently main conclusion is new here and was not that clearly presented in the discussion. It would be good to add a couple of sentences specifying the argument and its conclusions. The same goes for the next sentence. (38) The conclusions presented here paint a much clearer picture than section 5.3. The regional references (to the various faults and domes) are less clear in 5.3. Section 5.3 needs a thorough rewrite, and perhaps splitting in two sections to present the arguments more clearly. The first part could argue the conclusions about slow vs. punctuated events leading to broader and narrower age ranges, respectively, whilst the second part would present the tectonometamorphic development of the study area (leading to the conclusions in the second paragraph of section 6).

Please also note the supplement to this comment:
https://www.solid-earth-discuss.net/se-2019-10/se-2019-10-RC2-supplement.pdf

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