

Interactive comment on “Deeply subducted continental fragments: II. Insight from petrochronology in the central Sesia Zone (Western Italian Alps)” by Francesco Giuntoli et al.

Anonymous Referee #2

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Review of Giuntoli et al., ‘Deeply subducted continental fragments: II. Insight from petrochronology in the central Sesia Zone (Western Italian Alps)’

Summary

This paper uses the Sesia Zone (NW Italy) to understand both the conditions and timing of high pressure (HP) metamorphism and the nature of the assembly and exhumation of this preserved subduction zone. The authors use petrochronology to quantify the timing and conditions of metamorphism. Textural characterisation of samples followed by conventional thermobarometry, pseudosection and multi-equilibrium thermometry is used to define the both pre-Alpine high-temperature and Alpine HP metamorphic

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events. Laser Ablation U-Pb geochronology on allanite and zircon is used to place timing constraints on the pre-Alpine and Alpine events and to produce P-T-t paths for the separate blocks of the Sesia Zone. The authors conclude that the two studied blocks of the Sesia zone experienced different HP histories, with the internal zone having a more prolonged period at depth as material was accreted into the subduction zone. The external zone experienced a shorter period at depth later in the history. The two units were subsequently juxtaposed during exhumation, which occurred at rates of between 1.6-4 mm/yr.

General comments:

This paper represents a worthwhile study of a topic of interest: understanding the rates and timescales over which high pressure metamorphic processes happen in continental subduction zones. The paper provides some insight into the prolonged accretion process that occurred in the Sesia zone subduction zone and demonstrates how blocks with distinct deformational and metamorphic histories were juxtaposed during exhumation. This paper is therefore of interest to a variety of scientists concerned with processes occurring in subduction zones and those concerned with the use of geochronology and metamorphic petrology to explain large-scale tectonic problems. Although I am not an expert on Alpine geology or HP metamorphic processes, I think this manuscript is of merit and with some edits could be a useful contribution for knowledge about processes occurring in continental subduction zones. The authors could better highlight the significance of the findings- particularly the accretionary processes into the subduction zone at depth.

Reviewer questions:

1. Does the paper address relevant scientific questions within the scope of SE? Yes although the significance and importance of the question could be better highlighted in the abstract, introduction and conclusions.
2. Does the paper present novel concepts, ideas, tools, or data? I am not an expert in

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Alpine Geology so it is difficult to fully assess this as regards the topic. Methodologically the paper does not use new methods, however it does provide a solid dataset of allanite data- a relatively underused and novel geochronometer. The paper also uses the relatively new field of petrochronology, which with some edits to the discussion could be more effectively used to link the age and P-T data.

3. Are substantial conclusions reached? The paper is able to draw together a relatively large P-T dataset to explain the tectonic evolution of the area, however I think that the wider novelty and significance of the paper could be better highlighted, particularly for non-experts.

4. Are the scientific methods and assumptions valid and clearly outlined? Yes the methods are outlined, there are a few minor improvements for the presentation of the geochronology methods that could be done. The authors do not adequately outline the limitations of their study, particularly due to the fact that allanite crystals were not analysed in-situ but separated from the rocks.

5. Are the results sufficient to support the interpretations and conclusions? Yes largely, although the conclusions about the external zone are based on only one sample.

6. Is the description of experiments and calculations sufficiently complete and precise to allow their reproduction by fellow scientists (traceability of results)? yes

7. Do the authors give proper credit to related work and clearly indicate their own new/original contribution? Yes. Authors cite a lot of work that is 'in preparation' and 'submitted' which is not that useful, the authors may consider limiting the scope of the paper to mainly discuss the results presented in this manuscript.

8. Does the title clearly reflect the contents of the paper? Yes

9. Does the abstract provide a concise and complete summary? Yes, but I suggest adding something about the methods employed and the wider significance of the research question.

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10. Is the overall presentation well structured and clear? Some improvements could be made by restructuring the discussion.

11. Is the language fluent and precise? Yes

12. Are mathematical formulae, symbols, abbreviations, and units correctly defined and used?

13. Should any parts of the paper (text, formulae, figures, tables) be clarified, reduced, combined, or eliminated? The paper could be shortened by making the text more concise, particularly by restructuring the discussion

14. Are the number and quality of references appropriate? Yes

15. Is the amount and quality of supplementary material appropriate? Yes, the authors may consider including concordia diagrams of the zircon data.

Good points

• The paper does a very good and thorough job exploring the P-T conditions of formation of the samples with a very solid investigation of the P-T conditions using multiple thermobarometry methods. The authors are clear in the limitations of the P-T work and it is clear that this is the strongest part of the manuscript, particularly the consideration of garnet growth.

• This paper is appropriate for the journal, although the wider significance of the findings could be better discussed for a non-Alpine audience.

• The authors employ sound methodology to produce a solid dataset to support the interpretations and conclusions. However, some of the interpretation and discussion of the data could be expanded to better discuss the tectonic implications and the potential impact of the study.

Suggestions for improvement

1. Impact of the research The manuscript needs to more clearly and simply state the importance, novelty and impact of the research question and results for the fields of

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Alpine geology, HP metamorphism and petrochronology in the abstract, introduction and discussion/ conclusions.

2. Petrochronology The paper makes a good effort to highlight the need and methods for careful Petrochronological analysis of samples in order to adequately link ages to metamorphic processes. However there seems to be a discord between the aims and ideals of the authors and the reality of the data they present and the discussion of that data. This is not an unrepairable flaw- the authors just need to think about how to better organise their discussion to more adequately link the allanite ages with the careful P-T work that they have undertaken. This is possible but the manuscript needs to be more clearly written so that that reader can easily link together the ages, P-T data and interpretation

â€” The authors should explain why the allanite was separated from the rock rather than analysing the grains in-situ in thinsections- it would have been much easier to link the ages to the textures and therefore P-T data if they had been analysed in situ. The authors could think about maybe doing some extra analyses of the different textures observed to make sure of the ages of the interpreted textures, or if that extra work is not feasible, I recommend that the different inclusions in allanite are very clearly explained so that the reader can easily link the geochron and P-T work- perhaps with a table? â€” The authors may consider moving the section describing the allanite textures closer to the geochronology results so that they can be more effectively discussed with respect to the data. â€” It would be useful to have a petrochology discussion section separate from the main discussion- here you could carefully, clearly and systematically describe how the allanite ages, textures and P-T conditions fit together for each sample. â€” Did the authors collect any trace element data either from the allanite or the zircon, monazite or major phases such as garnet that could be used to link the geochronology to the P-T work. Could allanite be included in the pseudosection to show where these crystals were growing in the P-T path?

3. Development of discussion â€” As discussed above, it would be useful if you could

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separate out the petrochronological and geological discussions. If you clearly took the reader through step by step how all the allanite data is linked to the P-T data and then in a separate section explain how that data fits with previously published data. You could then discuss the wider geological implications of the data. â€” It would be useful to present a diagram- perhaps a schematic cross section or cartoon explaining the spatial correlation between units and age- what is the relationship in time and space between the IC and EC and could you show this in a figure? â€” There are lots of references throughout the manuscript to other manuscripts in preparations or submitted by the authors, I am not sure the journal policy on this, but I would recommend that the authors restrict the discussion to based on evidence presented in this manuscript rather than lots of other data that is not evident to the reader. This is particularly true in the section about fluids in the crust- if the authors would like to discuss this they should present more evidence for the interaction of fluids in the discussion, particularly of the accessory phase textures.

Other suggestions for improvement

1. Make sure you outline the reproducibility of your secondary reference material and explain if the quoted ages include propagated uncertainties taking into account the long term reproducibility of these secondary standards. 2. Quote how many analyses make up each age in the results section. 3. The discussion of the External complex interpretations is only based on one sample- perhaps consider more clearly stating the limitations of your study- and perhaps how viable interpretations based on one sample are. 4. Add grid references of samples somewhere in the manuscript or supplementary data 5. Data tables- where is the allanite data presented in a data table? 6. Include the concordia plots of the zircon data.

Also see annotations on attached PDF.

Please also note the supplement to this comment:

<https://www.solid-earth-discuss.net/se-2017-88/se-2017-88-RC2-supplement.pdf>

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