Here we reply to the comments of **Anonymous Referee #2**. We reported in Italic the **Anonymous Referee #2**

Note: in the document "Reply to Angiboust-Referee1" are available the modified figures and the Concordia diagrams, according to our replies to the two referees.

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.*

See our replies to the specific comments and **Annotations** (below)

2. *Does the paper present novel concepts, ideas, tools, or data? I am not an expert in 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.*

See our replies to the specific comments and **Annotations** (below)

3. *Are substantial conclusions reached? The paper is able to draw together a relatively large P-T-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.*

We will highlight better the wider novelty and significance of the paper in the revised version, according to the specific comments and annotations (see below)

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.*

Preliminary analysis of allanite for U-Th-Pb by LA-ICP-MS was indeed done *in situ*, on polished thin sections. However, to obtain more material for dating, allanite grains were subsequently separated and mounted in 1 inch resin mounts and polished.

There are several raisons why allanite grains were separated for dating:

- Grain mounts are more efficient as they allow selecting more spots for analysis in suitable areas.
- Grains mounts produce more likely equatorial cuts because polishing is optimized to obtain the largest sections possible at a given grain size. This is essential for LA-ICP-MS analysis of grains with several growth zones: if sectioning is not near-equatorial, one is more likely to drill through different growth zones.

We do consider petrographic control before dating to be essential. All mounts were imaged at the SEM with the BSE detector to document allanite textures. For each sample, both in the thin section and in the mounts, the allanite grains displayed the same textures and growth zones, allowing us to link the microtextural features found in thin sections to those seen in grain mounts. Yet grain mounts allowed us to obtain at least an order of magnitude more spot analyses per sample than thin sections. We note that U-Th-Pb ages from grain mounts analyses agree within uncertainty with the spot analyses made in thin sections.

We will add the details in this paragraph to the revised manuscript.

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.*

This is correct for the PT data, but regarding age dating two samples were analysed (FG12107, FG1420, Table 5). We are aware of this limitation, which is due to the difficulty of finding samples of suitable composition in the External Complex, as we stated on pg. 4 lines 13-14; this also explains why there are no P-T-t data available in the literature from this important complex in the central Sesia Zone (pg.4 line 4). The dominant rock type is orthogneiss devoid of suitable minerals to obtain the Alpine P-T-t path, as discussed in Giuntoli and Engi (2016). We will put more emphasis on this point in the revised manuscript.

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.*

All the citations "submitted" are referred to our companion paper (Giuntoli, F., Lanari, P., and Engi, M.: Deeply subducted continental fragments: I. Fracturing, dissolution precipitation and diffusion processes recorded by garnet textures of the central Sesia Zone (Western Italian Alps), Solid Earth, submitted.) that is currently at the review stage. The citations "in preparation" refer to Engi, M., Giuntoli, F., Lanari, P., Burn, M., Kunz, B. E., and Bouvier, A.-S.: Brittle deformation and rehydration of lower continental crust during subduction trigger pervasive eclogite formation. Implications on continental recycling, Geochemistry, Geophysics, Geosystems (G^3). At this stage this manuscript is still under review in G^3. We expect an editorial decision shortly and will update this reference or delete it if need be

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.*

We will improve our abstract in the revised version, adding what the referee requested here

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

See our replies to the specific comments and **Annotations** (below)

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*

See our replies to the specific comments and **Annotations** (below)

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.*

Thanks for this suggestion, we will include Concordia plots in the Supplementary Material.

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.*

See reply to comment #3 of the **Reviewer questions**

- *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*

See our replies to the specific comments and **Annotations** (below)

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

As stated in our replies to the Reviewer questions, we will improve this section in the revised version, according to the referee specific comments and annotations

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

- *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?

See reply to comment #4 of the Reviewer Questions. The link of age data and PT-data is based on critical mineral inclusions in allanite. These are documented in detail in section **4.4 Allanite textures and their microstructural relations** (Pg. 7), Fig. 4, Table 5 and Table S3, where all the chemical analyses of phengite and garnet included in allanite are presented and compared with analyses of the minerals defining the eclogite facies fabrics. We will strengthen this essential point to make the link more explicit in the text.

- *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.*

Good idea, we can pair up these two sections.

- *It would be useful to have a petrochronology 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.*

Ok, we will add a sub-heading to separate the petrochronology discussion from the main discussion and reiterate how we tied the ages to PT-data.

- *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?*

No trace element data were collected in this study for allanite, zircon and monazite, as these would be of limited utility in linking the age data to specific parts of the P-T path. Given the complex and multiple growth zones in garnet, we relied on petrographic and microstructural observations to link the allanite age data (t) to the PT data, which were all derived from the assemblage of major phases. Unfortunately, thermodynamic models for allanite and monazite so far are quite preliminary and available for but a couple of endmembers (Engi 2017), hence allanite and monazite were not included in isochemical phase diagrams (pseudosections).

3. Development of discussion

- *As discussed above, it would be useful if you could 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.*

See our replies to comment #2 of **Suggestions for improvement** above. Furthermore, in section **4.4 Allanite textures and their microstructural relations** we report for each sample what data and observations were used to link the allanite growth zones to the main mineralogical phases, and we summarize this in section **7.1 Linking equilibrium conditions with time constraints.**

- *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?*

We modify the cross section of Fig. 1c, adding the sample locations and P-T-t data, as suggested by the reviewer.

- *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.*

See our reply to comment #7 of the Reviewer questions

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.

We will provide the ages of our secondary standards in a separate table in the supplementary material. We do not propagated the systematic uncertainties (S_{sys}), because the value appear to be quite variable depending the reference material used (see **Burn, et al., J. Anal. At. Spectrom., 2017, 32, 1359-1377.**, reference given in section **6.1.1 Allanite geochronology).** This is especially true for U-Pb system as all the magmatic allanite used as standard have excess ^{206}Pb cause by the presence of ^{230}Th. However we will clarify in the revised

manuscript that the uncertainties given in the text and figures do not include the systematic uncertainties as defined by **M. S. A. Horstwood et al., Geostand. Geoanal. Res., 2016, 40, 311–332.** The low MSWD values (~0.5) obtained on the Th-Pb ages clearly support this assumption; we slightly overestimate the total uncertainties without propagating S_{sys}.

2. Quote how many analyses make up each age in the results section.

Ok, we can add such information, even though it is evident in Figs. 9-10 and Table S9 in the Supplement. For Zircon Dating (pg. 15 lines 29–32) we will add in the revised version: Detrital cores 27 analyses; Permian 53 analyses; Alpine 34 analyses.

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.

See our reply to comment #5 of the Reviewer Questions.

4. Add grid references of samples somewhere in the manuscript or supplementary data

Such a table is already present in the supplement (**Table S8 Location of the studied samples)**, as stated on pg.5 line 19 of the submitted manuscript.

5. Data tables- where is the allanite data presented in a data table?

They are presented in Table 5 and in Figs. 9, 10.

6. Include the concordia plots of the zircon data.

Yes, we will include them. See our reply to comment #15 of the Reviewer Questions

Annotations on attached PDF.

- *It would be useful if you could highlight up front in the abstract what the research question is and why this study is of importance.*

In our opinion this is essentially given in the abstract: we introduce the problem, we state why the study area is suitable to solve it and we say why this study is of importance (Lines 6-11 pg. 1). But we will add a more general statement about the research question up front.

- *Add a sentence here of what you did- methods*

Ok, we can add such sentence in the revised version

- *What is the signficance of this relatively long time period?*

At pg. 17 lines 18-20 we wrote " The three growth stages captured by our samples are at ~73 Ma, ~65 Ma, and ~56 Ma. The different P-T-t paths of Group1, 2 and 3 are interpreted to represent different continental sheets (Giuntoli and Engi, 2016) that experienced similar PT conditions but at different times (further discussed in section 7.3 Assembly and exhumation of the Sesia Zone). " and at Pg. 18 lines 26-30 "The IC shows several tectonic sheets, from several hundred meters to a few kilometres in thickness (Giuntoli and Engi, 2016), some of which may have moved independently (Rubatto et al., 2011; Regis et al., 2014) at some stages of the evolution. Some of the samples studied, while taken at most a few kilometres apart in the field, recorded similar P-T paths at different times, as reflected by the three age groups identified. This age difference may reflect relative mobility between such sheets, which are notoriously difficult to delimit in this terrain (Giuntoli and Engi, 2016)." See also our reply to Angiboust-Referee#1 comments

- *Highlight why these findings are significant.*

Ok, we will add a sentence or two in the abstract

- *An upfront selling point of this paper: Exhumed HP rocks provide an opportunity to understand processes happening deep under collisional orogens like the Himalaya today. Sesia is a window into those deep earth processes. Make sure that you make it very clear what the purpose and wider significance of the research is upfront.*

We agree with this suggestion: this message is located at line 26 of pg. 1. We trust that the present structure is transparent for the reader.

- *expand on what is not understood*

This is an introductory sentence; more on it follows (pg. 2 lines 1-14).

- *consider using another word*

Changed to "on the contrary"

- *Is this what you mean?*

Yes, ablated refers to "ablative subduction" (Tao, W. C., & O'Connell, R. J. (1992). Ablative subduction: A two-sided alternative to the conventional subduction model. Journal of Geophysical Research: Solid Earth, 97(B6), 8877-8904.). We will add this citation in the revised manuscript.

- *elaborate on this link?*

Modified for the sake of clarity in "suggest that fluid influx triggers deformation and mineral reactions in deeply subducted high-grade (granulite and amphibolite facies) domains."

- *Highlight the advantages over a modelling study?*

Ok, we will add one or two sentences about it.

- *Has this been introduced?*

Yes, the reference was given few lines later, but we can give this reference again here.

- *How is this related to the IZ?*

As we wrote in lines 8-9 at pg. 3 "The Insubric line is a major fault system of Oligocene-Neogene age that separates the SZ from the Southern Alpine," Furthermore, as we wrote at line 10 pg.3 "An important complex of the Southern Alps is the Ivrea Zone,"

- *Do all the geochronological/ thermochronological datasets record eclogite facies metamorphism?*

They did not, and that is exactly our point here (pg. 4 lines 7-8): "…but apart from those detailed above, none of the datasets have been linked in detail to petrogenetic conditions."

- *Did you consider undertaking Zr-in-rutile thermometry?*

Here we did not use Zr-in-rutile thermometry. However, Kunz et al. (2017) report data for one of our samples (FG 1249 from the Internal Complex); they show Zr-in-rutile thermometry (Table 3 of that study), and the maximum temperature obtained (640°C) matches the temperature we got for this sample using thermodynamic modeling (Fig. 6e).

- *Can you have a high pressure greenschist foliation?*

Yes, in the greenschist facies field you can have high pressure greenschist facies (e.g. 0.6 GPa) or low pressure (0.3 GPa)

- *of what?*

Of phengite, changed sentence in "In the EC, two distinct generations of phengite are distinguished based on their microtextural position" for the sake of clarity

- *You may consider moving the allanite texture descriptions to closer to the geochronology section*

Ok, we can move this section.

- *which other minerals?*

These include phengite, garnet, paragonite and rutile. We can specify these in the revised version

- *Were these dated?*

No, these were not dated.

- *Again you may consider moving this section down to be with the rest of the geochron.*

Ok, we can move this section.

- *Were the different rims resolvable when dated?*

We were able to distinguish between detrital cores, Permian rims (very sparsely developed), and Alpine rims. However, within the Alpine rims it was not possible to make absolute age distinctions between the rim generations. This is due to relative large uncertainties of the ages, as the narrow width of the rims only allowed small spot size during LA-ICP-MS measurements, which increases the analytical uncertainty.

- *Is there a reference to explain this?*

This is a textural description used by e.g.: Vavra G, Gebauer D, Schmidt R, Compston W (1996) Multiple zircon growth and recrystallization during polyphase Late Carboniferous to Triassic metamorphism in granulites of the Ivrea Zone (Southern Alps): an ion microprobe (SHRIMP) study. Contrib Mineral Petrol 122:337–358. and Root DB, Hacker BR, Mattinson JM, Wooden JL (2004) Zircon geochronology and ca. 400 Ma exhumation of Norwegian ultrahigh-pressure rocks: an ion microprobe and chemical abrasion study. Earth Planet Sci Lett 228:325–341. We will add these two citations.

- *Consider rewording this sentence*

Rephrased: "No resorption was allowed in sample FG1420, as garnet textures in the compositional maps show no evidence for corrosion".

- *What were these P-T guesses based on?*

The initial starting guess is a technicality used for reasons discussed in Lanari et al. (2017, sections **5.2.3. Stage 2 – go fast mode** and **6.3. Automated strategy [1]: limitation of multiple minima and solution finding**), The specific purpose is not to miss a minimum in this part of the PT space. This function searches a solution around the starting guess and follows the gradient in the objective function; there cannot be two local minima at high pressure (see Fig. 8 in Lanari et al. 2017). We will add a clarification in the revised paper (this reply is taken from our reply to Angiboust's Specific Comment p. 17)

- *Did any of the minerals involved in the metamorphic reactions contain Fe3+?*

In the studied rocks, some of the HP minerals do contain minor amounts of Fe^{3+}, but as we stated (pg. 10 line 1): "Fe^{3+} was ignored because of the lack of analytical data and suitable ferric end-members in solid solution models"

- *Are any images shown for these textures?*

No, these are not shown in the manuscript because they add no particular information

- *Excellent very good approach!*
- Thanks
- *You may wish to make a 'results' heading to make navigation easier.*

This is a good suggestion, will be adopted in the revised version

- *Were the garnet isomodes useful for constraining the P-T?*

For constraining P-T the garnet isopleth intersections were used. The garnet modal abundances predicted in those P-T conditions were matching the observed values.

- *Why did you not analyse the allanite in-situ? That would have been a useful way of linking the dates to the textural context?*

See reply to comment#4 of the Reviewer questions.

- *Report the reproducibility of the secondary standards and state whether the quoted uncertainties include propogated errors to take into account the reproducibility of the secondary standard.*

See our reply to comment#1 of other suggestion for improvement

- *Why was iolite not used for the allanite data above?*

Simply because it is not possible to apply a non matrix-matched standardization in Iolite. See Burn et al. 2017 for detailed explanations.

- *Outline how many analyses contribute towards each of these ages.*

See our reply to comment#4 of other suggestions for improvement

- *Consistent with Stacey and Kramers 1975 common Pb values*

We commented on this a few lines below (14-18, pg. 15) "These values are close to the predicted values of model lead evolution of Stacey and Kramers (1975) for this time range (Fig.1 in Burn, 2016). The exception is sample FG1347, in which the Tera-Wasserburg diagram shows a $^{207}Pb/^{206}Pb$ intercept of 0.787 ± 0.04 (MSWD on the regression of 2.5) and displays a $^{208}Pb/^{206}Pb$ intercept on the ^{206}Pbc-isochron diagram of 1.98 ± 0.082 (MSWD on the regression of 0.4). These values differ from the predicted values of Stacey and Kramers (1975)."

- *Is this shown in a figure anywhere? It would be useful to include in a concordia diagram (even in supplementary material).*

We will add such figure with Concordia plots in the supplement of the revised version.

- *typical of metamorphic zircon (i.e. Rubatto)*

True.

- *But it says in section 6.1.1 that the grains were separated- that is not in-situ.*

This is correct, it is *"in-situ"* only within allanite and zircon grains. We must modify our wording to state that the LA-ICP-MS spot location and diameter were chosen so as to resolve single growth zones of the mineral, rather than bulk grain analyses.

- *I would argue that as your allanite data was not collected in-situ in thin sections it is much more difficult to texturally link the allanite age data and the textures.*

Yes and no, we rely mostly on inclusions (of phengite, garnet, rutile) in allanite, which are readily visible in separate grains. See also our reply to comment#4 of Reviewer questions

- *Perhaps split into sub-headings of Pre-Alpine and Alpine*

Ok, we can do this in the revised version

- *Perhaps direct to relevant part of figure 11?*

Here we want to refer to all of it

- *Is there any chemical evidence that these garnet cores are HT?*

This conclusion is derived from the thermodynamic modeling results, as in this portion of the Alps granulite and amphibolite facies conditions were never reached during the Alpine history. Also, these conditions fit perfectly well with the ones of C; Lardeaux and Spalla, 1991;Rebay and Spalla, 2001, as we noted in lines 26-30 pg.16.

- *Make sure all acronyms are explained.*

We will add the missing ones in the revised version.

- *Why is this age not on figure 11?*

Because we do not have PT for this stage, and it is based on one single date.

- *State which samples these age groups are recorded in.*

This is stated, e.g. line 5 pg. 17 "based on samples FG1324 and FG1249 respectively"

- *What are the textural constraints for these ages?*

See reply to comment#2 of Suggestion for improvements

- *You need to explain how you have linked the ages to these metamorphic conditions*

See reply to comment#2 of Suggestion for improvements

- *How are these groups spatially organised- are they recorded in different samples*

Please, see lines 5-8 of pg. 17 and fig. 1b for sample location

- *State this before.*

It is stated, see lines 5-8 of pg. 17

- *It may be simpler here to separate the discussion into a two stage 'Petrochronological discussion' linking the ages and P-T conditions and then a second wider geological discussion thinking about the wider implications and citing relevant literature.*

Ok, we can do this in the revised version

- *Make sure the organisation is logical, I am finding the discussion a little hard to follow with the jumping between Petrochron discussion, discussion of preAlpine then Alpine, then preAlpine ages, and links to the wider context all seemingly jumbled up. I would recommend separating this out and trying to restructure to make this discussion flow a bit better and make it more logical for the reader to follow.*

Section **7.2 P-T-t paths of samples** first presents the data for the IC and then the data for the EC. In the revised version, we can use two sub-heading levels to make this clearer.

- *Why are they associated with those conditions?*

See our reply to suggestion for improvement, comment#3.

- *Explain these 4 groups in the same bullet point fashion as above- or show both in a table.*

Referee misunderstanding: we called these two samples "Group 4"

- *Try to show this in a schematic diagram? How the IC and EC are related in space and time in the crust.*

As stated earlier, we will modify the cross section in Fig. 1c, adding the sample locations and P-T-t data, as suggested by the referee.

- *Show this in a schematic diagram?*

See reply to comment above

- *This mention of fluids comes a little out of the blue- could you maybe explain earlier on why fluids may be important in your observed metamorphic textures, allanite-monazite-zircon textures etc., Try to base the discussion a little more on your manuscript rather than relying so much on lots of other submitted and in preparation manuscripts (even if that means simplifying the discussion a little).*

Ok, we will introduce the role of fluid earlier on in the revised version, as requested by the referee.

- *And what textures within the accessory phases support this coeval crystallisation with fluids?*

We linked several lines of evidence: 1. Fluid is necessary to mobilise the REE, Th and U elements to form allanite. 2. Fabric evolution (pg. 7, lines 9-10): "allanite prisms are elongate in the eclogite foliation, showing mutual intergrowth relations with other minerals defining this main foliation.", and 3. Age data (pg. 19 lines 8-9): "As allanite and zircon ages from these samples are identical within analytical uncertainties, it appears that this fluid influx also triggered the coeval crystallization of several accessory phases."

- *Link to the figure and again try and make this discussion a little more logical, you could organise this*
  1. *Petrochronological discussion of linking your allanite ages to P-T constrains and textures.*
  2. *Putting that all together to define a P-T path for your samples and linking that to other contraints.*
  3. *Being arm wavy and linking to the wider significance.*

We will restructure the discussion section as follow:

7 Discussion

7.1 Linking equilibrium conditions with time constraints: petrochronology

Here we will expand this section, adding a discussion of linking age data to P-T constrains and textures for each sample, as suggested by the referee.

7.2 P-T-t paths of samples

For the sake of clarity, we will subdivide this chapter into subchapters, as suggested by the referee:

7.2.1 Pre-Alpine-IC

7.2.2 Pre-Alpine-EC

7.2.3 Alpine-IC

7.2.4 Alpine-EC
7.2.5 Comparison P-T-t data IC-EC
7.3 Assembly and exhumation of the Sesia Zone
7.4 Implication for the subduction, assembly and exhumation of continental fragments
Here we will expand on the wider significance of our findings, as requested by the referee.

- *Should this not be in the conclusions? The discussion could be restructured here to systematically discuss the HP metamrphism and then in a new section the timing, conditions and evidence for juxtaposition of the different blocks and the tectonic model that helps to explain that.*

This paragraph serves as a summary of the discussion before the conclusions

- *Make sure it is really clear why your paper is significant and clearly explain (for a non-expert) what is new and exciting about this.*

We can add the following paragraph in the revised manuscript in section "7.4 Implication for the subduction, assembly and exhumation of continental fragments"

"Our work highlights that subducted continental terranes can be composed of several complexes that experienced major differences in their subduction histories (i.e. ~1 GPa and 100-180 °C for the Sesia Zone). Furthermore, these complexes can have been juxtaposed by tectonic contacts during the latest metamorphic stages (i.e. greenschist facies conditions) before being jointly exhumed to the surface. These complexes can be lithologically heterogeneous and may comprise several tectono-metamorphic subunits (from a few hundred metres to several kilometres in thickness). These may experience similar P-T paths but at different times (5-10 Ma apart). Differences in the P-T-t trajectories would thus reflect different tectonic sheets and attest to tectonic mobility in the subduction zone and/or several stages of internal deformation plus hydration at eclogite facies that triggered a pervasive HP-fabric and -assemblage (including datable accessory minerals).

To unravel such complex histories in subducted continental terranes, carefully established field relations, followed by microstructural and petrochronological analysis need to be combined to

- map and identify the primary and secondary tectono-metamorphic contacts;
- characterize the different fabrics and the mineral phases defining them;
- quantify the differences existing in P, T and t for each complex or subunit.

Finally, the heterogeneity of subducted continental terranes highlighted by this study should be considered when comparing results to numerical and analogue models that aim to investigate the mechanisms responsible for the subduction and exhumation of the continental crust."

- *Why is this significant/ new/ important?*

As comment above

- *Should you also have a bullet point explaining the EC?*

Ok, we can add such a sentence in the revised manuscript

Figures

- *Make sure the stars are obvious*

We modify the figure to make the stars more visible in the revised version of the manuscript.

- *Consider putting the stars on the cross section?*

Ok, we are happy do this in the revised figure

- *Clearly highlight how the allanite relates to each of these textures?*

In these microphotographs allanite grains are not visible at this resolution because they are tiny. If needed, we could provide two small-scale microphotographs with allanite crystals and their relation with the main foliation.

- *These pseudosections may be a little bit small, perhaps consider splitting them across multiple pages?*

Ok, we can expand these in the revised manuscript

- *Clearly explain what the red, blue and green ellipses mean.*

It is explained in the legend below each Equilibrium phase diagrams: these are the modeled garnet growth zones (Rim1, 2, 3)

- *Is this all allanite data? Where is the zircon data?*

We will introduce the Concordia diagrams in the revised version

- *The slope of these elipses looks a little odd- perhaps something to do with the correlation of uncertainties?*

That's correct. The correlation of the uncertainty is included in the plots, as described in Burn et al. 2017. That is the way it should be done to obtain the best isochrones.

- *Perhaps explain in another figure how these different parts of the HP IC are linked spatially? If there is accretion over time can you show this in a cross section explaining how the samples relate to one another in time and space?*

This is in fact visible from Fig. 1, but we could remind the reader here.

- *What is this age based on? Intercept TW age?*

Yes, we will specify that in the caption.

- *Again state what age this is- i.e. 238-206, 235-207?*

Zircon $^{238}U/^{206}Pb$ dates are given as the minimum and maximum range of individual analyses. We will add this specification in the revised version.

- *It may be useful to add another table explaining the 3 groups in the IC and the four groups in the EC and their relative age and P-T conditions.*

Misunderstanding: in the EC there is one group (Group 4). This table already exists (Table 5). We can improve this table adding a column where we specify to which group the samples belong, according to the referee's request.

We thank the **Anonymous-Referee #2** for so many detailed, constructive comments.

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