>It was a pleasure to read your manuscript. It is very nicely and concisely written. The research is perfectly conceived and meticulously executed.

Thank you

>Consequently, you left me very little space for comments. My principal comment is a question: Is there a reason you did not try to determine the activity of TiO2 using the approach by Ashley and Law (2015)?

The approach of Ashley and Law (2015) is useful for cases where rutile is absent. When rutile is present, as is the case in most of our samples, their approach would simply give TiO2 activity = 1. For rutile-absent samples under our PT conditions, the Ashley and Law (2015) approach also suggests high Ti activities close to 1, which seems supported by our observation of no noticeable difference in Ti concentrations between samples with and without rutile. As discussed in section 7.2, a Ti activity value of 1.0 is much higher than seem possible given independent constraints on the lower limit of quartz recrystallization temperature. Alternatively, using the Huang and Audetat (2012) TitaniQ calibration would provide temperatures consistent with higher Ti activity values (0.5-0.8, as mentioned in the text), however Ashley and Law (2015) provide a number of arguments against using that calibration. As mentioned by the first reviewer, "there is increasing evidence in the literature to support activity values substantially less than unity." More work is needed on this issue of TiO2 activity, but it is beyond the scope of our paper.

Second comment is a suggestion for Conclusion (P 11, line 22): Could you instead of fluid circulation within the shear zone consider that the high temperatures exist(ed) at 8 km and bellow, higher than in a typical continental setting although with the low geothermal gradient, while the upper 8 km of the crust is a thermal boundary layer caused by the uplift of relatively hotter rocks by the reverse component of the Alpine Fault? Overthrusting can in general induce a near-surface thermal boundary layer, the gradient in it being the function of thermal properties of rocks and rock exhumation rate.

Yes, thank you for the suggesting this possibility. Looking into this further, we agree that this is a likely origin of the "kink" we describe. We now point out that the pattern in the geothermal gradient we describe is similar to that predicted by 2D thermal models of rapid exhumation that do not involve fluid circulation (adding the Koons, 1987 numerical modeling reference). At the conclusion of the paragraph we now leave the matter more ambiguous, stating "The position of the kink in this study corresponds roughly to the maximum depth of earthquakes near the study area (Boese et al., 2012; Leitner. et al., 2001), suggesting that the onset of rapid cooling reduces temperatures to conditions where brittle processes dominate, and/or that fracturing associated with seismicity accentuates cooling by the infiltration of meteoric fluids to deep levels (Menzies et al., 2014)." The Menzies reference was added to indicate that there is evidence of meteoric fluids reaching these depths.

Minor comments: 1. Please replace "Ti activity" with "activity of TiO2 (aTiO2)"

Done

2. Please label consistently the temperature with symbol °C and put a space between the numeric value and the symbol.

Done

3. Please use consistently the appropriate term “geothermal gradient” or “geotherm”.

Done

P3, line 1: replace “schist foliation” with schistosity

Done

P3, line 5: delete either contractional or shortening

Done

P 3, line 10: please put the Greek letter gamma in front of the value for the simple shear strain.

Done

P 3, line 13: All that indicates a general strain. Are there vorticity analyses for the mylonites from the Alpine fault? In addition, you first write flattening and at the end of the sentence stretch. What was the geometry of the strain: flattening, plane strain or constriction?

We’ve clarified the language and added the requested information. It now reads “Characteristics such as boudinaged quartzose layers parallel to the shear zone, and reorientation of inherited, pre-Neogene lineations indicate that mylonitization involved ductile thinning by a factor >3 (Gillam et al., 2013; Norris and Cooper, 2003; Toy et al., 2013). Kinematic vorticity number (W_k) is estimated to be 0.7-0.85 in the mylonite zone (Little et al., 2016) or higher (Toy et al., 2013). Strain in the mylonite likely had a flattening geometry, but with S_1 exceeding S_2 by ~30 times (Toy et al., 2013).”

P 3, line 35: Consider removing minus sign in front of 340 °C and changing the wording accordingly.

Good idea. We changed it to a “decrease in temperature…” and removed the minus sign

P 3, line 37: I prefer not to use adjective “extensional” with “shear bands”. C’ are always dipping in direction of displacement, both in thrust- and normal fault- geometry shear zones (i.e., contractional and extensional settings).

Sounds good. We removed “extensional.”

P 5, line 30: no need for quotation marks with CL

Removed

P 5, line 33: why “apparent” rims?

Removed “apparent”

P 6, line 35: are garnets porphyroclasts or rather porphyroblasts?

Porphyroclasts (no change)

P 7, line 10: consider rewording to “wide temperature range from 360 °C to 500 °C”

We made this change.

P 7, line 34: double check if 6 billion years is correct value and correct abbreviation.

We adjusted this value in response to the first reviewer (see above).

P 9, line 13: could such a difference in geothermal gradient, at relatively small distance, be steady over a geological time scale relevant to this study, unless the cause for it was active?

We are not sure, but think variations in geotherm at this length scale are plausible. Variable dip angle of the Alpine Fault at a short wavelength has been proposed as an explanation for large variation in exhumation rate over short distances (e.g. Little, 2005 GSA Bulletin), and such changes could affect geothermal gradients. Similarly, upper crustal geothermal gradients have been demonstrated to vary substantially at short wavelengths in the recent drill holes (Sutherland et al., 2017).

P 10, line 22: in the previous sentence activity of TiO2 of 0.1 was indicated, and with wording in this line it reads as if it were a high value.

We have changed this paragraph significantly (see above response to other reviewer) and this sentence is no longer present.

P 11, line 22: is there independent evidence for fluid (meteoric or metamorphic) during dynamic recrystallisation?

Yes, Menzies et al. (2014). We’ve now added this reference.

Figure 12: consider flipping the vertical axis for the main part of the figure to be consistent with the insets (temperature decreases upward). In addition, is this rapid cooling or high geothermal gradient?

Yes, good idea, we have implemented this in Figure 12.

Assuming constant uplift rate, this is both rapid cooling and high geothermal gradient. We’ve changed the figure text to indicate this, e.g. “60°/km geotherm, rapid cooling”