Point per point reply Reviewer Comments 2

The ms presents interesting new data on two mains zones (free fluids and hot fluids zones). However, the authors have already published similar contribution in 2019, where they present the impact of hot fluid on AHe data. Only at the very end of the text, the authors show that when hot fluids are not present, it doesn't affect the AHe data. It is difficult to really understand what the message of the contribution is. Is that a methodological paper? If yes, the authors need to go further as the impact of hot fluids in fault affecting the AHe system has been already proposed. In addition, the authors present new thermal history modeling of the area, but they don't really discuss the implications for the eastern part of the Pyrenees. I strongly suggest that the authors propose further investigation on the exhumation of the eastern Pyrenees and compare with the other thermochronological data. Or the authors could investigate past geothermal anomalies and better present the new result of their contribution (AHe data are not affected in area where fluids are absent).

This paper, as explained in lines 183 to 186, is an extension of the study published in Milesi et al. (2019) allowing to better discuss at a larger scale the extent of the thermal anomalies based on AHe ages and REE patterns along four profiles across the Têt fault, in its footwall and hanging wall.

Abstract.
Add France after Pyrenees.
Done (line 10).
The passage with the second sentence of the paragraph is odd. I suggest "in order to investigate the evolution of the geothermal gradient and fluid flow, we used AHe + geochemical analysis to ...
The sentence has been changed (lines 11 to 13).
Paragraph 20: the authors gave sentences about exhumation for two zones, without using the data. What is the implication of the results? It is very unexploited.
As clearly stated now, the main goal of this paper deals with the effects of hydrothermal fluid circulations along a dormant fault on AHe ages. We use the cooling histories of both hanging wall and footwall determined far from the fault as references and do not intend to discuss the exhumation. (lines 19 to 23 and 25 to 26). This is beyond the topic of this paper and will be the topic of a new paper in progress.
Paragraph 25: it opens new perspective to what exactly? This could be a good angle to go to deeper investigation in the ms
The perspectives have been specified (line 25).
Paragraph 30: I am not sure to understand why the presence of water is required to heat production. Perhaps, heat advection need water, but water don't produce heat.
Hear we talk about the electricity production in well, referred to as "geothermal doublet". There the electricity production is a direct function of the water flow (discharge rate). This is now mentioned in lines 32 to 35 :" This type of system can show temperature and water discharge rate large enough for electricity production in "geothermal doublets", such as developed in the Basin and Range province (Blackwell et al., 2000; Faulds et al., 2010) or in western Anatolia, Turkey (Roche et al., 2018), with temperatures above 200°C (Bertani, 2012)."
Paragraph 50: about AHe temperature sensitivity range go higher than 90°C depending on the damage dose. I suggest adding 40-120°C and add Ault et al 2019 reference
Done (lines 53-54).
Paragraph 55: the goal of the paper "the study wants to test this tool both in areas lacking of hot fluids …". Please rephrase better to see what is new in the study. Why above 60°C?
This sentence has been changed and completed (lines 55 to 61).

Paragraph 60: and in general, more recent citations on low temperature thermochronological data of the Pyrenees are missing. Please add other papers than Verges et al.1995.
Done. New references have been added: Gibson et al., 2007; Sinclair et al., 2005; Metcalf et al., 2009; Whitchurch et al. 2011; Fillon and van der Beek, 2012 (lines 65 to 67).
Paragraph 65: remove the) between Later,) two minor…
Done.
Figure 1: Homogenization of the scale bar for each figure (a, b, c) could be good. What is the white square on fig c?
Done.
paragraph 80, line 3: add Ma after the numbers 300.3_3.1 and 291.2_2.8 Reference of Ar/Ar ages are missing It is ZFT and not ZFt. Please replace
Done. Maurel et al. (2008) reference for Ar/Ar ages was added (lines 88 and 89).
Figure 2: give the elevation or difference of elevation between samples. The addition of the AHe observed / predicted versus elevation could be nice.
Done.
Paragraph 85: it should be Apatite (U-Th)/He age yielded a large range of age between and not apatite yielded a large range of AHe age. Add error on AHe ages
Done.
Paragraph 95: could also add error on Ar ages
Done (lines 101 to 102).
Paragraph 100: please correct, it is not the low temperature data that reveal that the Canigou massif was exhumed and cooled but thermal modeling. What do you refer by rapidly cooled? Add values, like that it will be more homogenous with other given exhumation rates (see Paragraph 110)
Done, cooling rate values have been added (lines 108 to 110).
Paragraph 110: add more recent references about uplift and erosion in the Pyrenees, e.g.:. Vacherat et al. 2014, 2016, Ternois et al., 2019 etc for example
Done (line 86 to 87).
Section 2.2: since when hot fluids are circulating in the tet fault?
In section 2.2, a sentence was added to discuss about the timing of the onset of hydrothermal loops (lines 168-169).
Figure 3: color legend is missing. What is the brown line at the bottom, in the footwall?
The colours of the lithologies have been modified in agreement with Figure. 1 and lithology is now indicated in the Figure. 3. The brown line at the bottom has been deleted.
Paragraph 145: please add a little more information on how the numerical modeling
has been done and with which data
Some information has been added (see lines 157 to 171) but we cannot describe thoroughly the modelling, this is an other work already published (Taillefer et al., 2018) to which we refer.
Figure 4: could the authors add on the figure, the location of the samples? It can be useful I am not really sure about the purpose of this figure. What the authors wants to show?
The location of the sampling profiles has been added on this figure. The modelling and such a map helped us to locate the sampling profiles in “hot” and “cold” thermal anomalies areas along the fault.
Paragraph 180: the aim of this sampling… was to track the effects of recent hydrothermal circulation… but what is new in this study? The authors have already published this type of study, so it is important to go further.
In our previous work, we showed that actual hot (>60°C) water circulations have an effect on AHe ages. This work further shows that in areas devoid of present-day hot spring, apatite re-opening occurred in relation with recent or blind geothermal system thus affecting AHe ages that should therefore not be taken into account for regional thermal modelling. The re-opening of apatite grains can be traced thanks to combined REE analyses. We propose that combined U-Th/He and REE analyses is a useful tool to select grains devoid of hydrothermal imprint. The latter should be used

for apatite selection for thermal modelling. Moreover, this tool may be useful for exploration of blind geothermal systems. The conclusion has been rewritten to clearly state the original contributions of this work (see lines 558 to 588).

Paragraph 210: why is the reference Taillefer et al., 2018, in bleu and italic?

Done.

Paragraph 245: because the authors also measured the Sm content, they can use the value to add them and calculate the (U-Th-Sm)/He age

We cannot use Sm values, for different reasons. First, we did not measure the Sm for all apatite grains. Second, we did not use a solution spiked with Sm isotopes, therefore we cannot have the same accuracy than for U and Th measurement. Finally, adding Sm content would change AHe ages in a range of 0.02 Ma to 0.2 Ma, which is in the error values of (U-Th)/He ages.

Paragraph 260: the raw REE data should be add in the AHe data table for simplicity. Please add the raw values and not normalized to chondrite.

Raw REE data was added in the Table 1 and 2. Chondrite normalized REE data were replaced by measured values (in ppm) in the supplementary material too (Supplement section S5, Figure. 5).

Figure 7: it will be nice, if the authors add directly on the graphic, the free hot spring and with hotspring.

Done.

Paragraph 295: about eU (U+0.234xTh+0.0045xSm; Gastil et al., 1967), the presentation of the value could more simply presented 12 ppm instead of 12.3 ppm etc. What about the variation in the Th/U ratio? It can help to see if the Th and U have fractionated

Reference to Gastil et al., 1967 has been added line 313; Th/U ratio graphs are now showed in supplement section S.5. They do not help to discriminate whether the Th or U fractionated.

Figure 8 et 9: both figures are really difficult to read. They look very similar. Perhaps so diagram can go in the supplementary diagram and only light/heavy REE ratio could be presented.

These figures show very well AHe ages associated to the REE patterns for each apatite grain. As the combination of REE with AHe ages is very important in our work and as the measurements of REE represented a huge effort, we prefer to keep these figures in the manuscript.

Line 342 “Apatites from the hanging wall”

Done (line 357).

Paragraph 410-415: It will be interesting to add Cl measurement or compare the REE data from the apatite to discuss more about the dissolution / recrystallisation process. The reference Zeitler et al 2017 is good, but just is a summary of other studies (Shuster et al., 2006; Flowers et al., 2009; Gautheron et al., 2009; Gerin et al., 2017, Idelman et al., 2018, McDannell et al., 2018), that can be cited or for simplicity the reference Ault et al 2019 resumed all of other recent studies

We did not measure Cl content. At the regional scale, Cl values in apatite grains are available in Gunnell et al. (2009) and in our previous work (Milesi et al., 2019). These two studies show low Cl content in apatite in the DZ and outside the DZ, without important Cl intra-sample variability. This is why we did not measure it systematically. Ault et al. (2019) reference has been added in the discussion (lines 434-435).

Paragraph 525: the last line that describe the fact that if not fluids are shown, it doesn’t impact the AHe ages can be the angle of the paper. This is the main new result of the paper and it appears at the end. It is a shame, because it is very interesting. The authors could present this results in the beginning, and not focus to much about the influence of hot fluids, as it has been already published.

We do not agree with this comment. On the contrary, the main result is that AHe ages have been impacted in areas without present-day fluid circulations (location CAR and PLA). This suggest that in areas where past or blind hydrothermal circulations are suspected, the apatite grains may have an hydrothermal imprint that accounts for the AHe age scattering. In order to overcome this issue, we propose that REE measurements can help to select non re-opened grains and exploration of blind hydrothermal systems.

Figure 11: are you sure about the sum of REE because 20000 ppm is 20%. It seems that it is chondritic normalized values. Please verify the value as 1000 ppm of Sm is quite a lot and if it is the case, it will strongly change the AHe age. What about AHe age vs Th/U, AHe age vs light/heavy REE ratio? It will be better to add also the data outside of the DZ rather than the purple square

Indeed, in the submitted version the values reported in Tables 1 and 2 were Chondritic normalized values. According to this comment, we have changed for REE content in ppm as we have changed in Table 1 and 2. Sm content ranges from 24.9 to 431.8 ppm in the footwall samples and in a range of 74.5 to 526.1 in the hanging wall samples. See comment paragraph 245 for the impact on AHe ages, and paragraph 295 for Th/U ratios. We have added the data from outside the DZ (see Figures 11 and 13).

Figure 13: same comment than for Fig 11

See comments for Fig.11.

Figure 15: scale of the microscopic scale seems not be correct as the apatite crystal are really too small, or the scale

The scale has been corrected.

Supplementary: please report the raw REE content in ppm

Done, see Table 2 in supplementary.

Table 2; you can add directly the REE measurement in the same table

The sums of REE have been added in Table 1 and Table 2.