

Review of the manuscript entitled „The closure temperature(s) of zircon Raman dating” by Birk Härtel et al.

Referee: Beatrix Heller

Specific comments on the text and the figures:

L20: include also Palenik et al. 2003

L23: please define “high enough temperatures” and reformulate the sentence

L32: add Tc estimates “of the zircon Raman/damage thermochronometer...”

Figure 1: It would be nice to know the radiation damage density of the unannealed grain. If you want to be nice to colorblind readers do not use red and green in the same figure.

L39: What is your bandwidth? FWHM or HWHM? Please precise. Personally would prefer FWHM (rather than Γ) throughout the text as this is much more common practice in the zircon-damage-literature and would help the unfamiliar reader to better “read” the figures at one glance. But I understand that Γ is shorter.

L44-46: Try to explain better, if I remember it right from the literature there are different types of point defects needing different energies to be annealed. From the current formulation I don’t understand why some point defects anneal in stage I and others in stage III

L48: If I interpreted it right in the Data supplement you also measured other external bands. Either adapt the text (“..measured but not explored in detail but can be found in the supplement”) or kick it out of the appendix

Figure 2: Please indicate where this accumulation trend comes from (we don’t see the data it’s based on) and what it means. Make maybe a nicer arrow, the arrowhead can be confused with a data point.

L58 and following: please specify “moderate to high” radiation damage densities, give numbers if possible. Age? U and Th contents? You should at least estimate the damage from the Raman spectrum. Compared to other samples I would not say that your samples are very metamict.

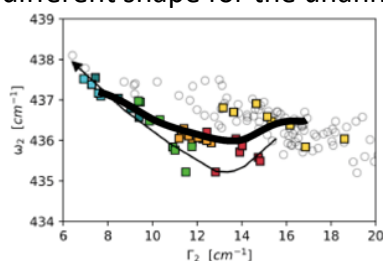
L59 and following: Try to better describe the grains: color? Size? Uniform sample? Zoning?

Section 2.2 (L63 and following): Give more information on the Raman measurements please. Acquisition times? Objective? Repeated measurements on the same spot, if yes how many, did you make any averaging? Did you measure several spots per grains? What is the excited volume?

I don’t get the need to cut the spectra into three to do a background correction. The same 3 sections you glued together before?

Section 2.3 (L70 and following): Please indicate how many grains you used for the experiments and how they were selected

Figure 3: The figure needs some improvement, please add a, b, c, d. I have a problem with the black trendlines (?) which seem to be added in a somehow aleatoric way. If you calculated a real trend, please say so. If it's just a rough indication please mention it, too, (the caption doesn't say anything) and maybe do not choose a black solid line but rather maybe sth gray, dashed and large? Especially for the v2 Band I would say that the trendline does not really fit the data. The picture below shows just as example an alternative option for a trend which fits the data equally good I would say. A more honest representation might be to draw very thin lines connecting the different annealing states of every grains. You could also include data points of synthetic zircon in the graphs. Like this it would make slightly more sense that the arrowheads go beyond the actual data. You could also choose a different shape for the unannealed samples



L90: changes in what?

L90: I don't see any break in slope between 700 and 800°C in Fig.3! I would rather say that the data overlaps pretty well... Between 600 and 800° eventually...

Figure 4: please add a, b, c, d. You should indicate the durations of the experiments in the captions or, if you find an elegant solution, directly in the graph. If I got it right the two experiments do not cover the same time range as there are only 5 blue but 7 red datapoints. Be honest with the reader and mention this somewhere if it's the case. And where do the knickpoints in the blue "trendlines" come from (esp. v2 and ER)??? There doesn't seem to be any data for this behavior. Assuming that at 1000°C the sample makes the same trend as at 600°C seems a bit too courageous to me. Again you could consider including the values for synthetic zircon.

Figure 5: It would be better to use the same colors as in Fig 3 and 8. Maybe extend the figure showing the same information for T vs bandwidth? I didn't test it but I can imagine that that could be interesting. In the end, this is what your model is based on.

L110:..."for which Geisler (2002) reported a constant value..." Can we see this somewhere? I don't. Or is this just the wrong citation and should be Zhang (2000)? Maybe indicate stages in Figure?

L120 and Figure 6: "...the unit cell shrinks anisotropically..": I have difficulties to see this in Figure 6. For the Geisler data maybe by omitting the two very scattered data points but for Colombo and Chrosh the data seems to be perfectly parallel to the lines with constant c/a ratio (especially if you consider a small error in the data which, unfortunately, is not presented). I am therefore not convinced if Figure 6 should be kept at all as it doesn't

present a very strong message. If you keep it please change the colors (purple and red are too similar) and you could gain some space and reduce the size by putting the legend in the lower right corner.

Figure 7: It could be interesting to indicate to which damage dose correspond the 12cm^{-1} width

L148: rather calculated than fitted

L154: you should rather compare the different initial damage doses than the absolute age. Note that the latter, on a geological time scale is not so different as your ages are lower carboniferous and the samples of Ginster 2019 have U-Pb ages of max. 570Ma and He ages down to 414Ma.

Table 1: typo in pos [4,4]

Figure 10: b) Please explain in the legend or the caption what the filling colors in b) between the lines mean /show. Maybe choose different colors for that it becomes clearer.

Data Supplement: please, mention the existence of the supplement also in the text. Otherwise I think many readers might miss its existence.

Please fix the caption of Supplementary Table 2: ϕ explanation is missing

Also T2: There are some intermediate steps missing (e.g. sample 6 $t=30$ and $t=1400$). Why? For the $t=0$ min steps you might replace the temperature by “unannealed” as in T1.