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Interactive comment on "Resolving the effects of 2D versus 3D grain measurements on (U-Th)/ He age data and reproducibility" *by* Emily H. G. Cooperdock et al.

Anonymous Referee #3

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This paper presents 2D measurement and 3D microCT data for >100 euhedral apatites from two igneous rock samples as well as 83 (U-Th)/He dates for a subset of these grains. It presents a methodology for efficiently acquiring microCT data for a large number of apatites (∼250) with a voxel resolution of 4-5 microns. The authors then compare the volume, surface area, grain mass, ESR values, eU values, and FT corrections derived by the two methods for this apatite suite.

This is a well-written, detailed paper. The primary benefit of this contribution is description of an efficient approach for microCT analysis and Blob 3D data reduction of a large number of grains for improved FT corrections and associated grain geometry,

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mass, and concentration information. This will allow others to use this methodology if desired. However, it significantly oversells the quantitative comparison of the 2D measurement and 3D microCT datasets, which should be more appropriately qualified. The deviations between the two sets of measurements presented here are almost certainly minimum differences that likely underestimate those associated with most apatites analyzed in (U-Th)/He labs. It also is unclear the extent to which the 5 um resolution of their microCT approach is an improvement over conventional 2D measurements.

1. The selection of two samples with only euhedral apatites of extremely high quality for this study means that the conclusions regarding the 2D-microCT data comparison are limited to only apatites of this kind. Arguably, such apatites comprise only a small fraction of grains analyzed in (U-Th)/He labs today. The paper casts these conclusions in the title, abstract, introduction, and discussion as being generally applicable. However, they're not. For example, the $\sim$2% difference in FT factors between the 2D and 3D measurements surely represent minimum uncertainties. For example, it would seem appropriate to insert the following text into this sentence in the abstract: "The data illustrate that the 2D approach...on high-quality euhedral apatites...systematically overestimates grain volumes..." The last sentence of the introduction should be similarly qualified. As should various statements in the discussion. For example, in section 4.2 the authors state that the greatest deviations are caused by user error and not the assumed grain geometry, but this may simply be because the authors only worked on the highest quality apatite subset that most closely approximates the chosen grain geometry. The higher deviations between 2D and microCT results that likely are associated with more typically analyzed apatites might make it more likely for the microCT method described here to be more widely adopted, so I'm surprised that only exceptional apatites were used in this study.

2. The title should indicate that this study is applicable to apatites only – "Resolving the effects of 2D versus 3D grain measurements on apatite (U-Th)/He age data. . ."

3. The 2D-microCT comparison seems to assume no uncertainty on the microCT data

despite the ∼5 um voxel size. Although section 2.4.2 describes various uncertainties associated with the 3D calculations, the bottom line is unclear. Could you please summarize clearly the final uncertainties on the 3D estimates and how this affects the 2D-3D comparison? In the end, how good is a 5 um resolution for determining 3D grain-measurements, especially for apatites on the small end of what is analyzed by (U-Th)/He?

4. The authors seem to dismiss the importance of surface roughness on their results, but detecting it is below their ∼5 um voxel size. Again, I feel that this points again toward the need to qualify some of their generalized statements about uncertainties.

5. In section 4.3 Regarding the discussion of inclusions, I encourage the authors to use more cautious language. As written, non-experts could read their language to mean that inclusions don't matter and picking apatites that contain them would be fine. We know this is not the case. Of course many apatites contain inclusions that aren't U-Th bearing and may not affect the data. The issue is the inability to discriminate between inclusions that are or are not U-Th bearing. Unless there is a way to discriminate, apatites with high-density inclusions shouldn't be analyzed.

6. The second and third paragraphs of the introduction should include appropriate references.

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