Geochronology Discuss., referee comment RC1
https://doi.org/10.5194/gchron-2022-7-RC1, 2022

Comment on gchron-2022-7

Anonymous Referee #1

Referee comment on "Technical note: Rapid phase identification of apatite and zircon grains for geochronology using X-ray micro-computed tomography" by Emily H. G. Cooperdock et al., Geochronology Discuss., https://doi.org/10.5194/gchron-2022-7-RC1, 2022

I appreciate the detailed and careful work that the authors have done developing and optimizing a protocol for microCT imaging of zircon and apatite. I believe that there is great, untapped potential for geochronological applications of microCT imaging of loose grains, grain mounts, and whole rock samples. Others have shown that microCT imaging can be used to quantify grain size, characterize crystal morphology, estimate surface-to-volume ratios for alpha-ejection corrections, and to identify inclusions and fractures in minerals. As such, microCT imaging could well become an important, routine tool for zircon and apatite chronology like it has become for (U-Th)/He dating of magnetite and other opaque oxides.

I also appreciate that the authors highlight the health risks of toxic heavy liquids like methylene iodide and bromoform. I agree that whenever possible, use of these chemicals should be avoided. Non-toxic heavy liquids such as LST, panning, and Wilfley tables are effective methods for separating out less dense minerals. However, as stated by the authors these methods are not capable of – or are not always terribly effective at – separating apatite from zircon.

While I believe that the work presented here represents an important contribution to the field of geochronology, I question the practicality of using microCT as a routine tool for mineral identification. Mineral identification is indeed a challenge in geochronology; geochronological opportunities are missed if less routinely dated minerals like baddeleyite or xenotime are not accurately identified in mineral separates. Apatite and zircon, however, are routinely encountered and have distinct crystal habits, optical properties, and differing solubilities. In the case of mineral identification challenges, other tools like Raman spectroscopy and EDS analysis have databases at hand that can identify mineral phases more directly as compared to relying on microCT density contrast. Further, not many geochronology labs are equipped with in-house microCT scanners. That said, having another analytical tool available to help with mineral identification – in the event that Raman and EDS are not available, and optical identification has truly failed – is useful.

In my personal experience, the challenge separating zircon from apatite in LST dense fractions that have not undergone MEI separation is often a problem of relative abundance. Some rocks have significantly more apatite than zircon. Identifying a small number of zircon crystals in an ocean of apatite can mean significant time spent at the picking scope. While spending more time at the microscope is safer than using MEI, I doubt that using microCT imaging to aid in mineral identification helps to save time.

16-18: Is it really that challenging to distinguish between apatite and zircon? The two minerals have very different crystal morphologies, optical properties, and acid solubilities.

36: Characterization of crystal shape, size, and inclusion content seems a stronger motivation.

57: I appreciate the discussion about health risks. I feel that most users don't know much beyond the fact that these chemicals are "toxic" or carcinogenic.

104: I would think that mounting and scanning grains likely adds additional time and cost to the process as well – not many labs have their own CT scanner.

160: It would be useful/interesting to demonstrate how often trained graduate students actually misidentify zircon and apatite. It would help to justify the study's stated motivation.

291-294: If a worker has already invested the time in preparing a grain mount for microCT imaging, why not simply go for the longer scan that will yield additional, more useful information about grain morphology, inclusions, ect?

Figure 3: Great figure. Very useful for predicting which minerals CT scans may be useful for. Maybe include other minerals of geochronological interest? How do zircon and apatite compare to magnetite and other oxide minerals that are now the focus of many (U-Th)/He studies?

Figure 7: As someone new to microCT imaging, this is also a great figure illustrating how different scan conditions affect image quality.