Geochronology Discuss., referee comment RC1
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Comment on gchron-2022-11

Richard A. Ketcham (Referee)

Referee comment on "A revised alpha-ejection correction calculation for (U–Th)□/□He thermochronology dates of broken apatite crystals" by John J. Y. He and Peter W. Reiners, Geochronology Discuss., https://doi.org/10.5194/gchron-2022-11-RC1, 2022

The contribution by He and Reiners of a revised correction method for broken grains for (U-Th)/He dating is simple, straightforward, and as far as I can tell, mathematically correct. It takes a previous approximate protocol taken on faith and authority and replaces it with something with a clear basis. What's not to like here?

One abiding issue that the authors could discuss more are the ramifications of not knowing when the fracture took place – was the grain broken during the mineral separation process, or was already a fragment in the rock. A further complication to the latter case is whether it was an isolated fragment in the rock, or a part of a larger, fractured crystal, where ejection would be matched by implantation across the fracture interface, but the fracture would also serve as a grain boundary for diffusive loss. How does uncertainty on this point affect the correction? One idea might be to run cases similar to Fig 2 and 5, such as one where "broken grains" were broken pre-deposition and thus should ideally not be corrected; the new protocol increases the overcorrection, resulting in a less salutary histogram of deviations. Accordingly, it would also be beneficial to also discuss, what are the textural clues for discerning when the fracture took place, and how reliable they are likely to be? There are some easy ones, like rounding suggesting transport, but perhaps the authors have additional experience to convey.

One other possible improvement is extending their thinking to the case of modeling: how should a broken grain be entered into thermal history modeling software? Does their reasoning on FT correction also extend to the proper effective radius for diffusion modeling on a sphere? For a grain broken on both sides, an infinite cylinder calculation would probably be the most appropriate, although the proper ejection profile for a cylinder would have to be derived. But, if for now we're stuck with converting everything to a sphere, what is the appropriate conversion?

Finally, if the broken grain boundary is inclined with respect to the c-axis rather than perpendicular, what is the appropriate length – the long edge along the c-axis, the short edge along the c-axis, or their average (which is roughly equivalent to the length along a

central axis, a reasonable estimate for the axis of symmetry)? In most cases, it probably amounts to a negligible difference, but for the sake of completeness it would be good to consider and discuss.

[line 30] Delete “both”

[line 93-94] Delete “since the widespread application of the technique”

[line 296] Does this sentence refer to the error bars? Maybe better to say it directly: "Error bars in date-elevation profile represent dispersion of dates corrected with new protocol only."

[line 333] Spell out XRCT