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Interactive comment on "Stepwise chemical abrasion ID-TIMS-TEA of microfractured Hadean zircon" *by* C. Brenhin Keller et al.

Anonymous Referee #2

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This is an interesting, well planned and well executed study. While its contribution to understanding the geological history of Jack Hills detrital zircons, the world's oldest known minerals, is relatively modest, the paper is valuable for exploring the new ways of extracting most information from zircon. I believe the paper can be published after moderate revision.

Comments linked to the text:

p.3 lines 14-15. "frequently presumed" by whom? There are several studies after Mattinson 2005 and Mundil et al. 2004 where the effects and conditions of chemical abrasion are explored in greater detail: Mattinson 2011 Canadian Journal of Earth Sciences, 48, 95–105; Huyskens et al. 2016 Chemical Geology 438, 25–35; Widmann et al. 2019 Chemical Geology 511, 1–10.

p.3 line 16. A more appropriate study to compare to is the paper by Amelin 1998 Chemical Geology 146, 25-38, where multiple fragments of 14 Jack Hills grains were dated by U-Pb ID-TIMS using air abrasion and some HF leaching. That study was indeed done before the advent of chemical abrasion, but it has substantial similarity in concept to this one, and I think it would be wrong to ignore it.

p.4 lines 16-17. Are you using both 3M HCl and 3.1M HCl? I doubt it âŸž)) Please correct the wrong number.

p.5 line 12. You can also consider the second study of 238U/235U in zircon by Livermore et al. 2018 Geochimica et Cosmochimica Acta 237, 171–183.

p.5 line 14. Strictly speaking, the Zr concentration in zircon depends on the Zr/Hf ratio, but this is a small change in normalisation (not really necessary to change).

p.5 lines 14-17. This way of getting Th/U rations does not make much sense to me. You can get these ratios independently from measured concentrations of both elements (by either ICPMS or ID-TIMS), and from Pb-isotopic systematics, and compare the value. This gives useful information about the open system behaviour in the U-Th-Pb system.

p.11 lines 21-22. Please take a look at the paper by Widmann et al. 2019 mentioned above where partially dissolved zircons produced by sequential leaching steps of chemical abrasion were studied by Raman spectrometry. This could help you to refine this speculation.

p.11 lines 27-31. I cannot remember the exact paper(s), but I am sure that ancient natural annealing of zircons during metamorphism and its effect of temporary suppressing the loss of radiogenic Pb, until the radiation damage builds up again, have been discussed before.

p.12 line 3. I doubt that it is correct to speak of "complete absence of water on the moon". "Low abundance of water" is more accurate.

p.12 line 4. Do you mean "in crystalline zircon"?

p212 lines 9-14. About sphene (btw you should use its proper name “titanite”) and e.g. apatite I would agree. But monazite? AFAIK its content of Pbc is as low as in zircon and baddeleyite. So I think there should be another explanation.

p.12 line 15 on. The temperature of decomposition of metamict zircon clearly depends on the degree of metamictisation. How metamict is the zircon that decomposes at 800°C?

p. 12 line 20. Baddeleyite is more easily soluble than zircon in HF. Direct extrapolation of this difference to response of these minerals to natural processes is unfounded (at least without additional tests) because the composition of the fluids, temperature and duration of exposure are quite different.

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