Geochronology Discuss., referee comment RC2
https://doi.org/10.5194/gchron-2022-20-RC2, 2022

Comment on gchron-2022-20

Yuri Amelin (Referee)

Referee comment on "Examination of the accuracy of SHRIMP U–Pb geochronology based on samples dated by both SHRIMP and CA-TIMS" by Charles W. Magee Jr. et al., Geochronology Discuss., https://doi.org/10.5194/gchron-2022-20-RC2, 2022

This manuscript presents a cross-calibration between two widely used techniques of U-Pb dating: isotope dilution TIMS assisted with chemical abrasion, and SIMS. Such studies are needed to assurure that the global geochronological dataset is consistent. Still, these studies are rare. Furthermore, previous similar comparisons were performed before the recent developments in both dating techniques, and thus have only limited applicability to the modern studies.

Overall, I think this is important and generally very good paper that can be published after minor revisions. The data, both previously published and new, are high quality, and the interpretations are generally sound. Some questions and suggestions for further improvements are below.

General comments

- It is important to emphasize two points about the “older – younger” distinction. First, it is only meaningful if the time interval between two points in time, e.g. CA-ID-TIMS date and SHRIMP date, is omly meaningful if the value of this interval is greater than its uncertainty. For example, the age difference of 5±4 Ma is significant and can be interpreted and discussed, whereas the age difference of 5±6 Ma has to be interpreted as two events occurring simultaneously. Second, the above distinction depends on the confidence level of the uncertainties, and this confidence level must be is specified. It would be even better not only report the confidence level, but also to justify its choice. I suggest that the treatment of age intervals and their uncertainties should be described in a separate section in the Methods.
- I suggest to expore possible correlations between the SHRIMP – ID-TIMS age difference and parameters such as U concentration, radiation dose (estimated from U, Th and Sm concentrations and the age), and Th/U ratio. This could possibly add new dimensions to the story.

Specific comments

Lines 45-46. To what extent the study of Jeon and Whitehouse (2014) is relevant to SHRIMP usage? Is the difference between the Cameca and SHRIMP design sufficiently big to make their results inapplicable to SHRIMPs?

Lines 78-80. The qiestion here is when the uncertainty of calibration is applied: before or after averaging the sample spot analyses. I think the latter is correct approach, as it prevents artificial uncertainty reduction due to repetition. The same dilemma exists, and is widely acknowledged, in Ar-Ar geochronology.

Lines 85-91. Make it clear that you talk about age (or 238U/206Pb) standards here. Temora-2 is indeed superior to SL13 as an age standard. However, as a concentration standard SL13 is significantly better than any Temora zircon. This is why modern SHRIMP studies use both standards together, each to its strength.

Line 102. Another good paper on the basics of chemical abrasion is Mattinson (2011) Extending the Krogh legacy: development of the CA–TIMS method for zircon U–Pb geochronology, Canadian Journal of Earth Sciences v.48, pp.95-105 (the special volume dedicated to memory of Tom Krogh).

Lines 131-134. There are pros and contras in using sampes collected for geological problem solving vs. dedicated natural standards. The downside of the "in the wild" approach here is that the "geological" uncertainty is typically greater compared to using natural reference materials (i.e., the best preserved and most homogeneous minerals). It would be interesting to discuss this topic in more detail.

Lines 138-139. Consider recalculating SHRIMP ages using the age of Temora zircon reported by Schaltegger et al. (2021) JAAS DOI: 10.1039/d1ja00116g. The difference is likely to be small, but this would still make the data a bit more accurate.

Line 147. Metcalfe (a typo). The same in line 302.

Lines 233-234. Sounds like zircon solutions were put into anion exchange separation in 6M

HCl. This does not make sense, and is not consistent with the Krogh (1973) chemistry or its later adaptations. Pb does not stick to the resin in this medium.

Line 235. Eluted together in what medium?

Lines 373-374. Strictly speaking, you should use a quadratic sum of both confidence intervals. The difference from using SHRIMP confidence interval would be small, however.

Section 4.1. I think it should be part of “Results” rather than “Discussion”.

Lines 430-434. Extrapolation of the trend defined from a narrow spread of values (in this case, the age) to a much wider range, such as shown in Fig. 3, is usually unreasonable. At the very least, show the uncertainty envelope for the entire range from 0 to 3500 Ma, not just ~100-500 Ma as it is done now. This will immediately and clearly show how much significance does this slope really have.

Lines 424-438. About OG1. All data that are discussed in a paper must be introduced in “Results”. It is not permissible to introduce any new data in the “Discussion” section. Hence add a brief section about OG1 to the “Results”.

Lines 434-435. Add references to support this statement.

Lines 436-438. Consider the distribution of radiation damage in inderstanding how chemical abrasion works. The damage can vary from individual recoil tracks (of ca. 100-150 nm) to U-rich bands in oscillatory zoning (microns or wider). Dissolution of individual recoil tracks would not make any visible changes in the zircon, but would impact the U-Pb system.

Lines 455-456. The extent of radiation damage can be estimated with the data available in this study, without any additional measurements (especially if we consider U and Th but ignore Sm, which may be a sensible approach). It would be good to seach for any possible correlations between radiation damage and U-Pb systematics.