Geochronology Discuss.,
https://doi.org/10.5194/gchron-2019-12-RC1, 2019

GChronD

Interactive comment

Interactive comment on "LA-ICPMS U-Pb geochronology of detrital zircon grains from the Coconino, Moenkopi, and Chinle Formations in the Petrified Forest National Park (Arizona)" *by* George Gehrels et al.

Glenn Sharman (Referee)

gsharman@uark.edu

Received and published: 27 November 2019

This manuscript by Gehrels et al. presents a new dataset of detrital zircon U-Pb dates from 29 samples collected during the Colorado Plateau Coring Project. The sample transect provides a detailed view of changing provenance and depositional age through Permian-Triassic rocks that have been well-studied for their scientific importance related to the environmental, biologic, and tectonic evolution of the western United States. Beyond its value in providing greater context for this particular region and time, this manuscript more generally provides an excellent case study of how de-

Printer-friendly version

Discussion paper

trital zircon LA-ICP-MS data may be treated during maximum depositional age (MDA) analysis. I suspect that the authors' approach, which involves consideration of four different approaches to calculating the MDA of each sample and, will provide a useful example for others in the geologic community to follow. This study is somewhat unique in that detrital zircon LA-ICP-MS MDA calculations can be compared to existing chronologies (paleomag, CA-ID-TIMS of detrital zircon and volcanic cobbles) to assess the degree to which MDA calculations approximate the true depositional age. I found this manuscript to be well-written and illustrated. I have one major reservation about the authors' conclusions and several minor comments (see Summary Comments below). I have also included line-by-line comments.

Specific Comments: 1. My biggest criticism of the conclusions of this manuscript is the inference that near depositional age zircon are air-fall in origin and older zircon are recycled. The authors repeatedly make this claim in the later part of the manuscript (e.g., Lines 700-701, 706-708, 718, 720, 740, 744-745, 765-766, 770-771, 820). However, relatively little attention was giving to substantiating this claim, besides merely stating that this is the preferred interpretation (Lines 679-681). A general comparison was made between grain size and contemporaneous zircon, yet when I view Fig. 13, I see several counter-examples (e.g., mudstone and siltstone that lack contemporaneous zircon and sandstone that has it). A simple plot of lag time (MDA minus model age) versus grain size would be helpful in evaluating this argument – I suspect that there will be a lot of scatter. I would be more convinced of this argument if morphology data were reported that showed young zircon to be euhedral and needle-like. More generally, the authors seem to imply (perhaps unintentionally) that near-depositional age zircon must be exclusively air-fall in origin. However, examination of modern river detrital zircon age distributions reveals that very young zircon are found in fluvial sediment that drain regions with active volcanism. I see no reason why the Chinle rivers that emanated from the Cordilleran arc would not similarly carry young zircon in their bedloads. Note that I am not suggesting that air-fall zircon are not present or important (I suspect they are). But I don't think a strong argument has been presented that show that young zircon are exclusively airborne. 2. A relatively minor point relates to how the PDP y-axis scale was presented in figures with an x-axis scale change (e.g., Fig. 7-8). The authors state that they increase the y-axis by a factor of 10x for the plotted age distribution >240 Ma. Yet, I wonder if the PDP y-axis should be scaled relative to the width of the plot and the age range plotted, rather than using an arbitrary number? For example, if a figure has a 50:50 split between 0-300 Ma and 300-3300 Ma, then the optimal ratio of the older plot would be a 10x y-axis increase. But if that sample plot had a 33:67 split, then the necessary y-axis increase would be lower (5x). Following this practice should ensure that the area underneath the curve for each plot is consistent.

Line-by-line comments: Line 24: "Inductively Coupled Plasma" ??? Line 25: How many detrital zircon grains? Line 57: "Formation and to" Line 79: How many grains total reported? Line 114: "yielded zircon U-Pb ages" – why the "/"? Lines 146-149: Suggest including reference to Marsh et al. (2019): Geosphere Lines 243-244: It's not clear to me what is meant by "boundaries selected at the youngest and oldest gap in ages". What constitutes a "gap"? I would prefer the method be spelled out sufficiently clearly that subsequent users could recreate it. Line 264-268: Coutts et al. (2019): Geoscience Frontiers demonstrated this well with a zircon standard as an example Line 513: How large? (i.e., suggesting reporting percentage range) Line 524: It's unclear to me why a 1.44 Ga peak would be associated with the Ouachita orogeny – this age mode is not well represented in Fig. 3 Line 527: There's a slight discrepancy between how sample names are reported in the text (e.g., 243-3) and how they are reported on the figures (243). Perhaps it would be better to use the same sample name throughout? My preference would be to include the dash, as this seems to convey a bit more information than just the number. Lines 578-579: This is a completely reasonable approach. That said, it may be worth incorporating the concepts recently discussed by Anderson (2019): Earth-Science Reviews. For example, it is possible that a certain degree of Pb loss occurs in zircon without unusually high U concentrations. Also, minor amounts of Pb loss in zircon does not necessarily result in a discordant analysis (depending on the age of the grain and degree of Pb loss). Line 685: Is there reason to be think that air-fall zircon are typically >60um in size? Is there morphological information from the zircon crystals themselves that suggest an air-fall versus transported (abraided) origin? Line 690: The authors contend that near depositional-age zircon are air-fall and older zircon are transported. Yet, I see no evidence presented that rules out the possibility of near depositional-age zircon that are transported by primary erosion of contemporaneous volcanic rocks. For example, Malkowski et al. (in press): AJS report a sample with >90% zircon of age 0.5 Ma from a river that drains the Lassen Volcanic Field in northern California. Clearly near-depositional age zircon can be transported in rivers. My concern here is the authors are implying (perhaps unintentionally) that near-depositional age zircon is exclusively air-fall in origin (e.g., Lines 700-701, 706-708, 718, 720, 740, 744-745, 765-766, 770-771, 820) when no data is provided to substantiate this claim. Lines 697-703: A simple plot of interpreted lag time (i.e., youngest zircon age versus age model, shown in Fig. 13) versus sample grain size would be helpful in evaluating the significance of the relationship between sample grain size (sandstone vs siltstone vs mudstone) and abundance of young zircon. This relationship is somewhat shown on Fig. 13. A cursory examination suggests that both sandstone and mudstone samples yield contemporaneous MDA calculations, with at least one mudstone (261) and one siltstone (210) yielding MDAs that are too old. Lines 768-769: "equivalents or immediately"? Lines 859-868: See summary comment above. This is a strong conclusion and theme throughout the later part of the manuscript, but is in my view not well documented by the data itself. Lines 1175-1176: Example of inconsistent use of sample names between text and figures (see also comment above) Lines 1183-1184: See summary comment above regarding how PDPs are scaled when an x-axis scale change is used. Lines 1203-1204: Unclear meaning in last sentence – possible typo? Figure comments: Fig. 13 is missing very fine sand on the x-axis scale. (it goes from mud, silt, f ss, m ss, c ss, etc.). The jump from silt (upper limit of 65 um) and fine sand (lower limit of 125 um) is an important one. Is it possible to add vf sand to the plot?

Miscellaneous comments: The sample coordinates (latitude, longitude) are missing from this manuscript, as far as I can. These should be included somewhere prior to publication.

Glenn R. Sharman

Interactive comment on Geochronology Discuss., https://doi.org/10.5194/gchron-2019-12, 2019.