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Interactive comment on "Technical note: on LA–ICP-MS U–Pb dating of unetched and etched apatites" *by* Fanis Abdullin et al.

Ziva Shulaker (Referee)

dshulaker@unr.edu

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This work investigates whether etching for apatite fission track dating affects the precision and uncertainty of same-grain U-Pb ages obtained via LA-ICP-MS. The authors conclude that U-Pb ages of etched and unetched apatite grains are within error of each other. However, etched grains tend to have slightly younger U-Pb ages compared to unetched grains. The purpose of the study is clear and is presented simply and understandably. However, clarification of some sentences and additional discussion would strengthen the gap in knowledge this study is filling.

Below I present the main points and minor points that require attention for revision. The major points are divided into scientific comments and the paper organization and

content. The minor comments are provided in bullet form, line-by-line. I hope the comments below are useful for ensuring that the key findings of the study are highlighted.

Major comments:

- A section summarizing previously published work, on apatite and/or zircon, and the necessity of this study should be presented before the sample description section. This will emphasize what gap in knowledge this study is filling.

- Because grains were mounted in a polished epoxy mount, it would be interesting to see if there is evidence for zoning in Cathodoluminescence (CL) or Back-scattered Electron (BSE) imagry. This could be a variable that impacts the collected U-Pb ages.

- There could be additional discussion between etched and not etched apatite U-Pb ages: to further discuss the differences between etched and not etched apatite U-Pb ages, perhaps discuss the average errors on individual U-Pb analyses for each sample. Often in U-Pb geochronology, individual U-Pb analyses can have high errors but the reported weighted mean age and errors can result in an age with a severely underestimated error. This could therefore mask whether U-Pb analyses on etched grains are more imprecise or less accurate compared to unetched grains.

- Are there noticeable differences between Th, Pb, and/or U concentrations collected via LA-ICP-MS before or after etching apatite grains? Or do these grains have very variable Th, Pb, and/or U concentrations? Does elemental concentration affect ages determined after etching? Homogeneous standards could help assess these points.

- An increasing number of studies couple same-grain multi-analytical techniques to obtain as much information as possible. For instance, performing (U-Th)/He and/or U-Pb and/or trace-element analyses on zircons or apatites. It would be interesting to discuss the effects of apatite fission track etching with U-Pb and trace-elements. I am unsure whether additional trace-elements were collected in this study, as the protocol that was used in this study is stated to have been developed for U-Pb and multi-element analy-

ses (line 101). If this data exists, I think this discussion could enhance the applicability and reach of this manuscript.

Minor comments:

- Switch the first and second sentences so that the objective occurs first and then the experiment is discussed.

- Lines 11-13: incorrect grammar; also clarify the “obtaining” of U-Pb ages; perhaps replace with something similar to as follows: “The objective of this study is to assert whether etching required for apatite fission track analyses impacts the precision and accuracy of same-grain U-Pb ages.”

- Line 14: determination of apatite U-Pb ages is vague; clarify “determination” – such as accuracy, precision?

- Line 16: instead of simultaneously; “double dating” is more accurate. I interpret the goal of this sentence to assert that this paper establishes the viability of double dating apatite via fission track and LA-ICP-MS.

- Line 19: “of five samples” should be replaced with “from five samples”

- Line 21: clarify – obtaining accurate and precise U-Pb ages?

- Lines 29-30: “This accessory mineral is often used for fission track, (U-Th)/He, and U-Pb dating”

- Lines 33-34: acronym should come after the term: eg., “laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS)”

- Line 35: clarify 238U levels - concentration?

- Line 40: clarify what causes the doubt and what the doubt is.

- Lines 40-43: (my personal preference is to avoid asking questions) could restate questions as: “The influence of chemical etching required for AFT dating of the preci-

sion and accuracy of same-grains analyzed for U-Pb dating via LA-ICP-MS remains to be quantified. To investigate this issue, the same unetched and etched apatite grains were analyzed via LA-ICP-MS for U-Pb dating.”

- Line 47: header can be simpler, such as: Sample descriptions

- Lines 59-62: validate using the age of a different previously dated sample; where is the other dated sample in relation to the sample in this study? Is it from the same unit?

- Lines 87-90: combining sentences for reading ease: “Approximately 300 apatite grains were extracted from each rock sample and mounted with their surfaces parallel to the crystallographic c-axis in a 2.5 cm diameter epoxy mount. The mount was polished. . .”

- Line 91: “sterile” is unclear; sufficient to state: “For our experiment, complete crystals lacking visible inclusions and other defects, such as cracks, were selected for analysis.”

- Line 97: remove “exactly” unless the center of the polished surface was measured for spot analysis

- Line 101: were other elements (REEs, Y, Sr, Mn, Mg, Cl) measured in this study? Or the same protocol that was developed to measure those elements was used? If they weren’t measured in this study, I would disregard from Table 2.

- Line 103: include the Iolite version

- Line 122: should be moved to the analytical procedures in the paragraph beginning line 94

- Lines 176-177: this contradicts the first sentence of the paragraph; there is clearly some effect to the U-Pb ages after etching, but it might be within analytical uncertainty and grains analyzed before/after etching have indistinguishable U-Pb ages.

- Line 178: word choices of “safely” and “simultaneous;” perhaps restate sentence to describe how this work shows that chemical etching for AFT dating doesn’t significantly

affect U and Pb ratios or concentrations, which makes apatite grains analyzed for AFT amenable to same-grain U-Pb dating via LA-ICP-MS.

- Lines 179-181: this should be in a new section above that discusses previous work. This will emphasize why your study is vital for providing data that validates same-grain AFT and apatite U-Pb dating via LA-ICP-MS.

- Line 217: in the Figure 2 caption, note whether the ages reported are averages, weighted means, etc.; are the uncertainties one or two sigma?

- Line 223: in figure 3, what are the errors shown on the graph?

- Line 455: see comment for line 101: if additional elements (REEs, Y, Sr, Mn, Mg, Cl) were not measured, can disregard from table 2 as this wasn't the set-up for these experiments.

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