

Overview

Denyszyn and others couple atom probe tomography (APT) and numerical modeling to examine α -recoil processes in the U-Pb system of baddeleyite. They find that only one of the two samples (Great Dyke of Mauritania) shows any heterogeneity in U and Pb distribution, and they disregard the other sample (Hart dolerite), concluding that it is an interior region of a crystal exposed along a cleavage plane. Through APT, the authors identify both ^{238}U and ^{206}Pb profiles that reflect a combination of crystallization and recoil effects. They estimate a mean recoil length for the ^{238}U -series (80–90 nm) that is larger than prior estimates and identify some plausible causes for this discrepancy.

Overall, I find the work and conclusions very sound, and I find this to be an important and relevant contribution to the U-Pb and U-series communities' understanding of recoil processes at a very fine scale ¹. My primary criticism of this work is the lack of clarity and organization in the figures, captions, and some of the text, which collectively make it difficult to efficiently interpret the authors' findings.

Because the scientific work is sound and the conclusions relevant to the field of geochronology, I would recommend the manuscript for publication in *Geochronology* if the following comments are sufficiently addressed. In addition to these specific comments, I encourage the authors to review the manuscript with special attention to clear figures, prose, and descriptive figure captions.

Graham H. Edwards

General Comments:

- The introduction is well-written and provides a very thorough background.
- I found it cumbersome to interpret figures with unlabelled y-axes. While the labels were floated in the plots as text boxes, the authors should label axes directly wherever possible (e.g. Figs. 3, 4, 6–9, 11) and position the y-axis and corresponding tick labels outside of the plot area to ensure they are as legible as possible (Figs. 3,4,7). I recognize that the authors prepared their figures in Excel, which offers limited customization capabilities, but all of these edits are possible in Excel and will significantly improve figure readability.
- The authors refer with some frequency to Supplementary Data, including three spreadsheets. While I take no issue with referring to this supplementary data, these spreadsheets are poorly curated and have inadequate metadata. In the case of Supplementary Data File 3, this does not appear to contain the data the authors describe on line 274.

¹My expertise is in the realm of U-series recoil processes and U-Pb geochronology. I have limited experience in baddeleyite crystallization processes and APT. My limited commentary on those topics reflects my naïveté, and I trust that referees more expert in these topics than myself can provide constructive commentary.

Moreover, Supplementary Data Files 2 and 4 are multi-page xlsx files. For clarity, the key plots should be presented as figures with descriptive captions so that readers can efficiently interpret the authors' key points. I think it is good practice to include the xlsx files to illustrate the methodological process, but these should not be the primary format of presenting/describing nuanced supplementary data.

- For clarity in the results and discussion, I advise the authors to use a consistent and specific set of directions (e.g. edge, interior) that consistently describe orientation relative to the original sample rather than terms like “left” (lines 219–30) that are dependent on the orientation of the APT specimen.
- Some of the text-based figure captions (lines 510–41) do not correspond with the current figure numbers. In general, the authors should double check that captions and in-text references correspond with appropriate figures and supplementary data files.
- I find the use of a convolution of the U distribution with the redistribution distribution appropriate for estimating the distribution of recoil transported radiogenic Pb. However, I think there should be a more extended discussion at the beginning of §2.3 justifying this approach. Lines 168–9 give this a good start, but I think most readers would benefit from more detail on this specific method.
- The Cr caps appear to be at angles to the z-axis of the FIB-milled specimens. This is curious, as the authors model systems with the z-axis orthogonal to the crystal surface. The authors should comment on how the needle-shaped specimens are oriented relative to the surfaces of grains they were milled from. Are the caps just apparently skewed or does this reflect the angle of the needles relative to the crystal surface.
- The authors conclude that the Hart dolerite is an exposed cleavage plane and do not consider it further. However, they consider spaces between bladed crystals as fast diffusion pathways of atom loss by recoil. They should comment on how these specific systems differ. (Presumably, the cleavage plane was exposed by a very recent breakage and was within strong crystal lattice previously, but I still think an explicit statement is worthwhile).

Comments by line #:

- 97** I think this is based on the observations of Davis and Davis (2018), right? I think it's worth referencing the relevant study again with this statement.
- 201–10** Please mention how the abundances across the transect are calculated. Are they calculated from the entire disk of each depth bin? Also please mention that a distance of zero refers to the tip of the specimen (and the corresponding crystal surface). I could figure it out by comparing figs. 5 and 6A, but an explicit statement in the text and corresponding figure captions (e.g. 6) would be very helpful.
- 228–9** Please elaborate on the statement “but deviates from the measured profile near the start of the high U peak because of accumulation of recoiled Pb.”

- 230** Wouldn't ^{206}Pb recoiled from the left be relatively inconsequential compared to Pb recoiled from the ^{238}U peak? The process should be described in more detail.
- 274** Supplementary Data File 4? Supplementary Data File 3 reports elemental abundances. (GCHRON-2023-15-Supp Data File-3-R80_02479-v01-Full Mass spec Proxigram_plot.xlsx)
- 306–9** This sentence is unclear, as Fig. 3 depicts model results. If this bears on the shape of high-to-low U transitions, it should be explained in more detail, or a different figure should be referenced.
- Figs. 1 & 2** Ideally present the same samples in each panel A and panel B rather than alternating.
- Fig. 3** I'm curious that it's a Normal distribution with $\sigma = 82$ nm that fits the profile. The standard deviation must be a function of the average R (40 nm), but is this mathematical relationship straightforward/quantifiable?
- Fig. 7** Please put panels A and B on equal x-axis scales to make comparing between the two panels easier.
- Fig. 9** Mention in the caption that the curve is a splined fit to help guide the eye and does not represent actual MSWD values.
- Fig. 11** Use consistent directionality in panels A & B (x increases in different directions).