Geochronology Discuss.,
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Interactive comment on "Potassium isotopic variability and implications for ^{40}K-based geochronology" *by* Leah E. Morgan et al.

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I would like to thank Ryan Ickert for his thoughtful and thorough review. We will respond to his comments here.

Comment: I strongly recommend that 1. The effect of variable 40K/K is calculated for one or both of astronomically calibrated and U-Pb calibrated 40Ar/39Ar.

Response: We agree that adding these calibrations would make the manuscript more useful. This is relatively simple for the astronomical calibration, and this will be added to a revised manuscript.

Comment: So to summarize, the manuscript would benefit from:

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1. Detailing quantitatively, using equations, how to go from δ41K (relative to SRM 999b) to 40K/K, or even better, 41K/39K and 40K/39K) and how to calculate the atomic weight.

Response: These equations will be presented in a revised manuscript.

2. Tabulating the 40K/K (or even better, 41K/39K and 40K/39K) and atomic weights used in the calculations.

Response: Parameters used will be tabulated in a revised manuscript.

Comment: The results (e.g., figure 2) are couched in terms of "bias", considering extreme values. In my opinion, it would be far more useful if the distribution of 40K/K was calculated, and a probabilistic result was presented. In other words, treating this as an uncertainty in the 40K/K and propagating that uncertainty onto the age results... The magnitude of the variability in age associated with 40K/K variability should be compared to other systematic uncertainties. Is the decay constant uncertainty large or smaller? Is flux monitor age uncertainty larger or smaller?

Response: Uncertainty in 40K/K will be propagated into age equations in a revised manuscript.

Technical Corrections:

The (approximate) isotope composition of K should be described in the introduction for a reader who is not intimately familiar with isotopes of K.

Response: This will be added to a revised manuscript.

The Merrihue and Turner reference in the first paragraph is confusing because the placement implies that this is the reference for the half life, and not for 40Ar/39Ar geochronology. It might be worthwhile substituting a more general reference, like Harrison and McDougal, that encompasses both.

Response: This sentence will be rearranged and will include the McDougall and Harri-

son reference.

I think that at this point in geochronology Steiger and Jager is not really a good reference for decay rates and branching ratios. It describes an agreed “convention” and doesn’t detail how the quantities were compiled or derived. Beckinsale and Gale or Min et al. are probably more appropriate. Or Renne et al. (2010/2011) if you really want to stir the pot.

Response: Beckinsale and Gale, as well as Min et al., will be added as references here.

The notation of 40K/K is peculiar and possibly confusing. 40K/K here means the molar 40K/(39K+40K+41K) and is not really a standard notation in isotope geochemistry. It’s not obvious to me what a suitable difference would be – my preference would be to simply write 40K/39K in the text, and then if necessary, use 40K/K in equations (or another symbol indicating fractional 40K). In any case, 40K/K needs to be defined quantitatively somewhere in the manuscript.

Response: 40K/K is used in literature going back at least to Beckinsale and Gale, and including Min et al. 40K/39K would not be accurate as it doesn’t include 41K in the denominator. 40K/K will be defined in section 1, and ‘f’ will be retained in equations for consistency with symbols used by Min et al.

Other notations are also confusing. The use of lower case “f” and “r” when the upper case letters are in common use for unrelated quantities in the equations makes this very difficult to read – the sentence on line 80 is a good example of this. It would be more straightforward if Greek letters were substituted.

Response: As noted above, the use of ‘f’ is for consistency with Min et al. ‘r’ was selected as the ratio of ‘f/f’ for symmetry: r=f/f, compared with the equation R=F/F.

All quantities used in calculations, decay constants, atomic weights, ages, and other constants should be either listed in the text or tabulated. Almost none of them are listed

in the text. They should all be explicitly referenced.

Response: These will be tabulated in a revised manuscript.

In equation six the symbol for the decay constant is lambda with a subscript lambda. I assume that this is a typo and that it is meant to be lambda subscript new.

Response: This is actually not a typo. ïĄňïĄň, while a slightly awkward symbol, represents the decay constant calculated using ïĄď41K values for material used in activity counting. This is defined just below equation 4.

Figure 1 is only very slightly modified from Figure 6 in Morgan et al. (2018), which may be a copyright violation. I appreciate that the lead author of that paper is the author of this submission, and that there are only so many ways in which a ranked-data plot can be drafted, and I am not accusing the author of plagiarism or an ethical violation. However, it's clear that the same electronic figure was used in this submission – the fonts, colors, spacing, and all the style characteristics are identical. The "modifications" appear to be just a few extra lines and a couple of arrows. I would urge one of two actions, either the figure be substantially modified so that it no longer resembles that in Morgan et al. (2018), or the publication staff of Geochronology confirm that they can legally print this figure via an existing license from the RSC (the publisher of JAAS) or a one-off agreement.

Response: The RSC does not require authors to obtain permission to reproduce material from their own works (see quote below). The appropriate permission will be listed in the figure caption.

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Figure 2: The dots are presumably point estimates of a continuous function, so the

curve should be drawn instead of the points, and the plausible range should be bracketed. The point estimates outside of the range were confusing initially before I realized there was an implied curve denoting a continuous function. As mentioned above, this figure would benefit from redrafting as a “change in age vs. absolute age” with an uncertainty band derived from different values of 40K/K.

Response: The curve will be redrawn as a continuous function, and plausible ranges noted.

Figure 3: The colours are nice, but the figure would be easier to read if it were made wider and had a few labelled contours instead of colours. One has to look back and forth from the colours to see what the quantities are, and the contours will just be straight lines. They could easily be labelled without cluttering the chart if it were wider, and they could be labelled outside the top and right edges of the figure.

Response: This figure will be redrawn with contours in a revised manuscript.

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