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Interactive comment on "Percent-level production of ^{40}Ar by an overlooked mode of ^{40}K decay" *by* Jack Carter et al.

Jack Carter et al.

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We would like to thank Anonymous Referee #2 (hereafter referred to as AR2) for their timely and detailed comments. We are encouraged that they identify as a geochronologist and find this to be a useful contribution to the literature. Overall, we are pleased that AR1 finds no overall fault with our conclusion that on balance, there is good physics-based evidence to support an ECground/$\beta \sim 200$, and that although AR2 identifies that they do not have the expertise to judge the physics argument, they believe it is a useful contribution to the geochronological literature.

Response to specific comments (numbered as they occur in RC2):

1) (line 70) The 1.02 MeV gamma is the sum of the 511 keV annhiliation photons from

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the interaction of the positron with an electron. This is included in McDougall and Harrison (1999) adapted from Beckinsale and Gale (1969) in which it is not included. The 1.02 MeV will be an observation in any counting experiment however it is not a decay emission and as such we do not include it in Figure 1.

2) The energy that dictates if positron emission is possible is the Q value. The Q value is the difference between the initial mass state and final mass product. This energy is shared between the outgoing neutrino, atomic excitation of the daughter system, recoil energy, and possibly nuclear excitation of the daughter system. The Q-value therefore includes the excitation of the daughter system. However, positron decay can only compete with the electron capture if the Q value of the electron capture decay itself is greater than the threshold 1022 MeV value requiring the positron decay to go directly to the ground state. We will amend this to provide a clear statement in a revised manuscript.

3) Quantum selection rules place formal constraints of the possible transitions of a system from one quantum state to another. In our case it places constraints on the possible set of transitions from the parent 40K state to the daughter 40Ar. We will include this definition in the revised manuscript.

4) (Figure 2 caption) We will indicate in the caption that the uncertainties are either unknown or too small to plot.

5) (Line 287) We will correct flux monitor to fluence monitor.

6) (line 303) For a 40Ar/40K = 0.08, and using the decay constants in our Table 1 (λEC* = 0.580e-10 and λtotal = 5.463e-10 for Min et al; and λEC* = 0.590e-10 and λtotal = 5.473e-10;), we used the K-Ar equation:

time = 1/λtotal*ln(1+ λtotal/λAr or EC**40Ar/40K).

This yields dates of 1028.05 Ma and 1014.24 Ma for the Min et al. and our revised decay constants, respectively. This is a difference of 13.81 Ma, or about 1.3 %. We have reproduced this calculation and believe that our original calculation is correct, though we welcome any correction from AR2 if we have misunderstood.

In a revised manuscript, we will provide a figure that provides more detail. The small kink at 100 Ma is an Illustrator artifact and will be smoothed in a revised manuscript.

7) (line 306) We will change the date to 28.2 Ma.

Technical Corrections:

8) (Line 97) “They” refers to EC and positron, and will be clarified in the revised text.

9) (line 124) The missing quantity is a beta, and we will ensure this is typeset correctly in a revised text.

10) (line 148) Unfortunately we neglected to define E_max, but will do so in a revised text.

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