

Geochronology Discuss., author comment AC2
<https://doi.org/10.5194/gchron-2022-16-AC2>, 2022
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Reply on RC2

Alexandria J. Koester and Nathaniel A. Lifton

Author comment on "Technical note: A software framework for calculating compositionally dependent in situ ^{14}C production rates" by Alexandria J. Koester and Nathaniel A. Lifton,
Geochronology Discuss., <https://doi.org/10.5194/gchron-2022-16-AC2>, 2022

We thank Dr. Irene Schimmelpfennig for her helpful comments to improve the manuscript.
We have responded to each comment in detail below

- *Lines 55-56: It could be good to clarify that the extraction procedures from mineral/rock phases other than quartz also still needs to be developed before these materials can be envisioned for geologic applications.*

We thank the review for their comment. We have clarified this point in the manuscript at the end of our introduction (line 63-64)

Lines 80-81: This sentence is unclear: does "well-constrained" refer to the exposure history? Natural variability of what? I don't understand the point of the sentence.

Yes, "well-constrained" does refer to the exposure history. We have edited the sentence for clarity.

- *Lines 81-82: The focus on quartz is also due to the fact that extraction procedures for other minerals or lithologies have not yet been developed or validated.*

We note that the first extraction techniques for in situ ^{14}C utilized whole rock samples (e.g., Jull et al., 1992; 1994) in the introduction and were ultimately abandoned in favor of the simpler quartz systematics. (lines 55-56).

- *Line 149: Were elevation differences between individual samples at each site insignificant? Or were the concentrations corrected for them?*

In this ^{14}C CRONUS-Earth global calibration from the references cited, there are samples at secular equilibrium along elevation transects that span a broad altitudinal range at a particular latitude. Those samples are incorporated into the estimate of the SLHL production rate. In addition, there are the primary CRONUS-Earth calibration sites with multiple samples that span limited altitudinal ranges. Sample locations (latitude, longitude, and altitude) are of course considered in deriving the SLHL production rate estimates, as those are required input for the scaling model. This dataset will be included in the supplement.

- *Lines 153-154: What is the calibrated value generated by the UWv3 calculator?*

The output value generated by the UWv3 calculator is 0.868, using dipolar R_C parameterization from that calculator's implementation. This value is the fitting parameter that is multiplied by the reference production rate for ^{14}C , 15.8 atoms/g, which is that derived from the integral of the flux and excitation functions for ^{14}C production from neutron and proton spallation in quartz, at SLHL (P_{Qref}). This yields a value of 13.7 at/g/y, which is the same value (well within 1 sigma uncertainty) that we derive using a dipolar R_C parameterization similar to that in the UWv3 calculator in the manuscript (see line 154) and already mentioned in text (line 156).

- *Lines 159-165: This should be simplified by saying that you calculate a correction factor $P_{\text{Qcal}}/P_{\text{Qref}}$, which gives 0.854 and which you multiply by the P_{CDpred} of all other tested mineral and rock phases. However, how reliable is this correction for other compositions, which are associated with other excitation functions than quartz?*

We prefer to keep the equation grouped as presented because the P_{CDpred} and the P_{Qref} are both theoretical - we then multiply that by the geologic calibration of quartz. Algebraically it doesn't matter of course, it's just seems more logical to us in that order. Therefore, we prefer to keep the theoretical components together and separate from the geologic component.

The correction is as reliable as possible given our current knowledge of the scaling of fluxes, reaction cross sections, and geologic calibrations. We have attempted to quantify the uncertainties on this in general in the text already. As more excitation functions are measured for the reactions of interest here, and mineral specific geologic production rate calibrations are conducted, our confidence in these corrections will undoubtedly improve.

- *Lines 237-238: Would it be possible to list the elemental ^{14}C production rates, for direct comparison with those given in the Masarik (2002) abstract? This is also what is commonly done for the highly composition dependent ^{36}Cl production.*

We thank the reviewer for the suggestion and have derived a list of production from each element within the text (shown as atoms g-element $^{-1}$ yr $^{-1}$) at a SLHL location, and added discussion in the text of this. We have also provided a table below, which is now Table 6 in the manuscript.

Element	PR_{SLHL} (atoms g-element $^{-1}$ yr $^{-1}$)
O	29.01
Si	0.84
Mg	2.19

Al	1.67
Fe	0.10
Na	15.59
K	0.08
Ca	0.06
Ti	0.05
Mn	0.03
P	0.22

- Related to this, I suggest you should clarify whether or not the software also calculated production rates for compositions that differ from those considered here theoretically.

The software framework can take in any XRF elemental analysis for any rock or mineral type. The user can input any elemental oxide percent from any location and calculate a theoretical production rate. We tried to compare predictions for as broad a compositional range as possible. We have added a sentence to line 143 for clarity.

Caption of Table 1: Shouldn't this be "Oxide compositions... and accordingly calculated number densities"? (It should be clarified what the numbers are.)

The table lists the percentage of oxide compositions for each mineral and rock. These percentages are used to calculate the number densities as in equation 2 (line 139). We

have edited the caption for clarity.

While we were at a conference, Dr. Schimmelpfennig suggested in person to include a figure of the production from minerals and rocks from a presentation about this work, so we are including that in the revised manuscript per her request.

Please also note the supplement to this comment:

<https://gchron.copernicus.org/preprints/gchron-2022-16/gchron-2022-16-AC2-supplement.pdf>