^{26}Al-^{10}Be exposure age/erosion rate calculators: update of constants file from 2.2 to 2.2.1

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1 Summary

This describes changes between versions 2.2 and 2.2.1 of the constants file used in the CRONUS-Earth online ^{26}Al-^{10}Be exposure age and erosion rate calculators. These changes reflect recent publication of i) new measurements of the ^{10}Be half-life, and ii) a new comparison of the Be AMS standards used at the ETH-Zurich AMS facility with the KNSTD standards. For the majority of calculator users, neither of these changes will have any significant effect on calculated exposure ages or erosion rates.

2 Background

2.1 New measurements of ^{10}Be half-life

Version 2.2 of the constants file used a ^{10}Be half-life from Nishiizumi et al. (2007). Recently, both Korschinek et al. (2010) and Chmeleff et al. (2010) have remeasured the ^{10}Be half-life. Their results agree with, but are more precise than, the Nishiizumi result. Thus, we have updated the value of the ^{10}Be half-life to this new result.

2.2 Renormalization of muon interaction cross-sections

The online calculators compute ^{10}Be production rates due to negative muon capture with the method of Heisinger et al. (2002a), and due to fast muon interactions using the method of Heisinger et al. (2002b). The cross-sections for ^{10}Be production by muon interactions used in both of these publications were derived from ^{10}Be measurements made at ETH, that were normalized to the 'S555' Be isotope ratio standardization in use at ETH. Thus, to be consistent with the other production rate calculations in the online calculator, that are normalized to the '07KNSTD' standardization of Nishiizumi et al. (2007), these cross-sections must be renormalized. In version 2.2 of the calculators, we assumed that the S555 standardization was consistent with the KNSTD standardization, and we adjusted muon interaction cross-sections on that basis. Recently, Kubik and Christl (2010) compared the S555 and 07KNSTD standards, which showed approximately a 1% difference between KNSTD and the ETH standardization. Thus, we have used the new results of Kubik and Christl to renormalize the muon interaction cross-sections to the 07KNSTD standardization.

3 Importance

The revised value of the ^{10}Be half-life will result in small changes to very old exposure ages or very low erosion rates. The effect on relatively young (tens of thousands of years) exposure ages will be negligible.

The revised values of the muon interaction cross sections will slightly affect erosion rate calculations when erosion rates are very high. However, this effect will be negligible in nearly all situations. Furthermore, the magnitude of the adjustment is much smaller than the uncertainties in the muon interaction cross-sections, so this adjustment will not have any geologically significant implications.

4 Changes to MATLAB code and version numbers

This update changes only the constants file that is used by the MATLAB code. Thus, the only m-file that is modified is the file 'make_al_be_consts_v22.m' that generates this constants file. The constants file generated by this script, which is used in the calculators, has version number 2.2.1.

5 Published documentation superseded

The changes described here mean that parts of the published documentation for the online exposure age calculators (Balco et al., 2008) are now obsolete. In addition, parts of the online documentation describing the update from version 2.1 to version 2.2 are also obsolete. The following sections of this document reference the specific parts of that paper that have been superseded.

5.1 Updated decay constant for ^{10}Be

The ^{10}Be decay constant is now defined as $4.998 \pm 0.043 \times 10^{-7}$ yr^{-1}. This supersedes the value stated in section 2.4.2 of Balco et al. (2008). In addition, this supersedes the value given in the online documentation for the update from version 2.1 to 2.2.

5.2 Revision of muon interaction cross-sections for ^{10}Be production

The new value for $f_C f_D f^*$ (the summary cross-section for ^{10}Be production by negative muon capture in quartz) is $5.05 \pm 0.35 \times 10^{-4}$. The new value for σ_{190} (the cross-section for ^{10}Be production by fast muons with energy 190 GeV in quartz) is $8.6 \pm 1.2 \times 10^{-29}$ cm^2. These values supersede the values stated in the 'MATLAB function reference' appendix to Balco et al. (2008), as well as the values stated in the online documentation for the update from version 2.1 to version 2.2.

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