Earth and Planetary Science Letters 502 (2018) 291–292

Contents lists available at ScienceDirect

Earth and Planetary Science Letters

www.elsevier.com/locate/epsl

Corrigendum

Corrigendum to “The million-year evolution of the glacial trimline in the southernmost Ellsworth Mountains, Antarctica” [Earth and Planetary Science Letters 469 (2017) 42–52]

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ARTICLE INFO

Article history:
Received 9 August 2018
Accepted 24 August 2018
Available online 5 September 2018
Editor: A. Yin

Summary

This corrigendum fixes an error in the reporting of ^{21}Ne concentrations, which affected one batch of samples that included the bedrock depth profile from which cosmogenic ^{10}Be, ^{26}Al and ^{21}Ne were modelled to constrain the age and exposure history of the Patriot Hills (Fig. 8 in the manuscript). Re-modelling the cosmogenic nuclide data using the corrected ^{21}Ne data yields an apparent exposure age of 3.5–5.1 Ma. This corrects an age published as 2.1–2.6 Ma in Sugden et al. (2017), and reinforces the conclusion of the original paper that the glacial trimline is pre-Quaternary and that the climatic conditions necessary for its erosion last occurred in the Mid-Miocene.

The revised Supplementary Table 1 has been updated with corrected ^{21}Ne concentrations and consistent reporting of ^{10}Be concentrations. The revised Supplementary Table 2 has been updated with ^{21}Ne exposure ages for the affected batch of samples. Below, we describe the revised model results and present a revised Fig. 8. Tables 1 and 2, Fig. 8 and its caption replace those in the original paper. The corrections reinforce the conclusions of the original paper.

Revised depth profile modelling

^{21}Ne, ^{10}Be and ^{26}Al concentrations were analysed at six depths within the 2 m core. Revised Fig. 8a models the best fitting exposure age and erosion rate for each individual nuclide assuming constant exposure since the bedrock was first exposed. The three nuclides reveal incompatible histories and thus show that the surface must have experienced a complex exposure-burial history. We then apply the Balco and Rovey (2008) method to test if the whole dataset is compatible with a single-cycle exposure-burial history. The linear fits show burial ages of 0.6 ± 0.5, 14 ± 2 and 8 ± 1 Ma for the ^{10}Be–^{26}Al, ^{21}Ne–^{10}Be and ^{21}Ne–^{26}Al isotope pairs, respectively. These discrepancies indicate a multi-cycle exposure-burial history. Using these data, we employ the global marine isotopic record of climate change collated by Lisiecki and Raymo (2005) as a basis for modelling an exposure-burial history that is compatible with the ^{21}Ne, ^{10}Be and ^{26}Al concentrations (Revised Figs. 8b, 8c). We assume that the bedrock surface was exposed during ice-free periods when the marine δ^{18}O value is below a certain threshold, and totally shielded from cosmic radiation when the marine δ^{18}O value is above the threshold. This threshold and the age of first exposure are parameters in the model. The modelling shows that the best fit to the measured concentrations is achieved with a δ^{18}O threshold corresponding to current values between 3.40 and 3.43‰ (uplift corrected for the past), which are slightly higher than the current value of 3.23‰. The apparent age of first exposure is between 3.5 and 5.1 Ma. The optimum result reveals an

DOI of original article: https://doi.org/10.1016/j.epsl.2017.04.006.
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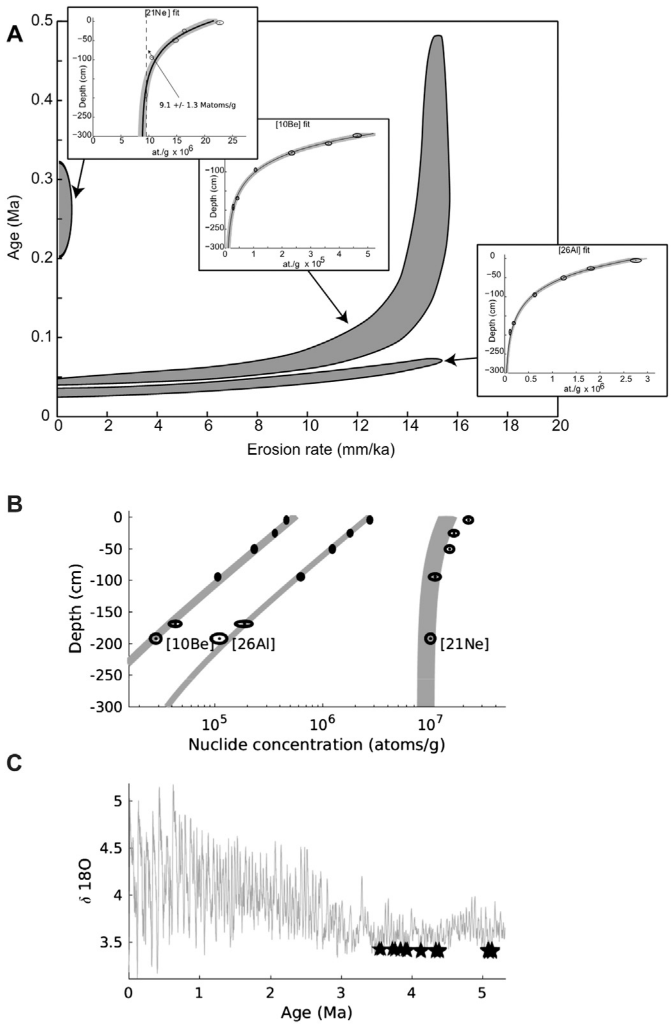
https://doi.org/10.1016/j.epsl.2018.08.053



Revised Fig. 8. Modelling of the bedrock depth profile. (a) Plot showing the best model fits to each individual nuclide (inset plots) assuming constant exposure, and the incompatible relationships between age and erosion rate that result from making this assumption (1σ confidence limits). The modelling assumes constant exposure, rock density of 2.60 $\mathrm{g\,cm^{-3}}$, and no ^{10}Be or ^{26}Al inheritance. Models with inheritances of 9.1 ± 1.3 10^6 $\mathrm{atoms\,g^{-1}}$ fit the ^{21}Ne dataset within 1σ. Results from the stable ^{21}Ne database indicate that the total exposure time of the surface is 267 $\pm$ 65 ka and the average erosion rate was <0.3 $\mathrm{m\,Ma^{-1}}$ during that time (1σ confidence limits). ^{10}Be and ^{26}Al production rates and corresponding attenuation lengths were calculated using Matlab code from online calculators formerly known as the CRONUS-Earth online calculators v. 2.3 (Balco et al., 2008) and a ^{21}Ne/^{10}Be production rate ratio of 4.1 was assumed for spallation and fast muons (Balco and Shuster, 2009). (b) The 52 model runs described below in (c) that fit the ^{21}Ne, ^{10}Be and ^{26}Al data within 1σ confidence limits. (c) The results of modelling an exposure-burial history marked by glacial cycles as represented by the LR04 isotopic marine record (Lisiecki and Raymo, 2005). The model runs that are compatible with the measured ^{21}Ne, ^{10}Be and ^{26}Al concentrations (1σ) correspond to first exposure ages between 3.540 and 5.135 Ma. The model assumes that the surface is exposed during ice-free periods when the δ^{18}O is under a certain threshold, and is totally shielded from cosmic radiation during ice-covered periods when the δ^{18}O is above the considered threshold. Surface erosion rate during ice-free periods and continuous uplift relative to the δ^{18}O were also tuned for the model to fit the data, yielding an erosion rate of 1.5 m $\mathrm{Ma^{-1}}$ and an uplift rate of 0.14‰ δ^{18}O $\mathrm{Ma^{-1}}$. An ice-free erosion rate of 1.5 m $\mathrm{Ma^{-1}}$ corresponds to a total surface lowering of 21 cm and an average erosion rate of 0.04 m $\mathrm{Ma^{-1}}$ since the first exposure. As suggested by the best fits of the constant-exposure model to the ^{21}Ne dataset, a ^{21}Ne inheritance of 9.1 ± 1.3 10^6 $\mathrm{atoms\,g^{-1}}$ is allowed. Results show a δ^{18}O threshold corresponding to current values between 3.40 and 3.43‰ (uplift corrected for the past), which are slightly higher than the current value of 3.23‰, and would be expected for a surface that is above the glacier surface today.

uplift rate of 0.14 δ^{18}O ‰ $\mathrm{Ma^{-1}}$ and an average interglacial surface erosion rate of 1.5 m $\mathrm{Ma^{-1}}$. We recognise that there are uncertainties involved in relating Antarctic glaciations directly to the LR04 dataset, and yet random deviations from the record over 80 cycles will not have a major influence on the main conclusion that the bedrock was first exposed more than three million years ago.

Appendix A. Supplementary material

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.epsl.2018.08.053.

References

Sugden, D.E., et al., 2017. The million-year evolution of the glacial trimline in the southernmost Ellsworth Mountains, Antarctica. Earth Planet. Sci. Lett. 469, 42–52.

Balco, G., Rovey, C.W., 2008. An isochron method for cosmogenic-nuclide dating of buried soils and sediments. Am. J. Sci. 308 (10), 1083–1114.

Lisiecki, L.E., Raymo, M.E., 2005. A Pliocene–Pleistocene stack of 57 globally distributed benthic delta O-18 records. Paleoceanography 20 (1).

Balco, G., et al., 2008. A complete and easily accessible means of calculating surface exposure ages or erosion rates from Be-10 and Al-26 measurements. Quat. Geochronol. 3 (3), 174–195.

Balco, G., Shuster, D.L., 2009. Production rate of cosmogenic Ne-21 in quartz estimated from Be-10, Al-26, and Ne-21 concentrations in slowly eroding Antarctic bedrock surfaces. Earth Planet. Sci. Lett. 281 (1–2), 48–58.