Supplementary informations to:
U-Th and ^{10}Be constraints on sediment recycling in proglacial settings, Lago Buenos Aires, Patagonia

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1 Specific surface area measurements

The specific surface areas S of the samples were measured using N_2 adsorption. S was calculated by determining the amount of adsorbed gas needed to create a monomolecular layer on the sample's connected surface. Each sample was placed in a vacuum-sealed vessel (itself placed in a liquid nitrogen bath). First, a non-adsorbing gas (in this case, He) was introduced in pressure increments and the injected volume V_{na} was recorded. After having removed the gas, a second series of gas injections was run with an adsorbing gas (in this case N_2) and the volume V_a recorded. The volume of gas adsorbed on the surface of the sample at each pressure increment is therefore V_a - V_{na}. Assuming that the surface of the sample interacts with a monomolecular layer of adsorbed gas (following the BET theory, Brunauer et al. (1938)), the volume of this layer, V_m, is derived as a function of V_a - V_{na}, valid for pressures between 0.05 and 0.35 of the N_2 saturated vapour pressure. Specific surface area is calculated as:

$$S = \frac{V_m.A.N_a}{m.V_{STP}} \lambda_{230} N_{230} + (1 - f_\alpha^{230}) \lambda_{234} N_{234} \tag{1}$$

where N_a is Avogadro's constant, A is the adsorption cross-sectional area of the adsorbing gas molecule, m is the mass of the dry sample, and V_{STP} is the volume of one mole of adsorbed gas at standard pressure and temperature. However, in our samples, most of the adsorption occurred at low relative vapor pressure. This corresponds to a Langmuir type isotherm typical of microporous solids where the adsorption of gas takes place completely at very low pressures, making the BET theory inappropriate for analyzing the adsorption isotherm. We used instead a different mathematical model, the Dubinin-Radushkevich equation (Dubinin & Radushkevich, 1947). This equation takes into account values of relative vapour pressure in the initial part of the isotherm ($\leq$ 0.1 of the N_2 saturated vapour pressure). This is fundamental for the characterization of this type of solids, and allows the derivation of the volume of the monomolecular layer of adsorbed gas, hence the specific surface area by using the previous equation.

2 Determination of profiles ^{10}Be ages

We show here graphically (Figures 1 and 2) the results of the Monte Carlo optimization of the profiles ages, erosion rates, and inheritance, following Hidy et al. (2010).

3 Th removal during leaching

Th is poorly soluble, hence after ejection by α recoil, it is most probably readsorbed onto mineral surfaces. The leaching protocol is supposed to remove it. In order to evaluate whether the leaching procedure has been efficient at removing exchangeable Th, we test whether the results are compatible with scenarios where Th is not removed or only partially removed.

To test it, we consider that a total readsorbtion of ^{230}Th after ejection from the mineral is equivalent to no ejections at all, that is $f_\alpha^{230} = 0$. We also test with $f_\alpha^{230} = \frac{1.176 \times f_\alpha^{234}}{2}$ (half of the theoretical value described in section 2.3.1), which correspond to an intermediate case (partial removal of Th during leachings).

Interestingly the relations between t_{recycl} and $k_{238}^{pre}/k_{238}^{post}$ remain the same. The differences concern the likelihood of the solutions, and the relation between k_{234}/k_{238} and k_{230}/k_{238} (see Figures 3 and 4). With $f_\alpha^{230} = 0$, the fit to the data is poor and unrealistic values of k_{234}/k_{238} larger than 3 are necessary. When f_α^{230} is increased, the predicted value of k_{234}/k_{238} decreases, but remains larger than 3, the fit to the data becomes better, and the t_{recycl} optimal solution remains around 100 kyrs.

Given the fact that the fit to the data is less good and the estimated value of k_{234}/k_{238} becomes very large as the value of f_α^{230} is decreased, we conclude that the leaching procedure is highly efficient at removing exchangeable Th, even if we cannot exclude that a small amount of exchangeable Th can remain after the leaching protocol. Importantly, the average recycling time estimated from the inverse procedure remains of the order of 100 kyrs, even with moderate amounts of Th.

References

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Hidy, A., Gosse, J., Pederson, J., Mattern, J., & Finkel, R. (2010). A geologically constrained monte carlo approach to modeling exposure ages from profiles of cosmogenic nuclides: An example from lees ferry, arizona. *Geochemistry, Geophysics, Geosystems*, *11*.

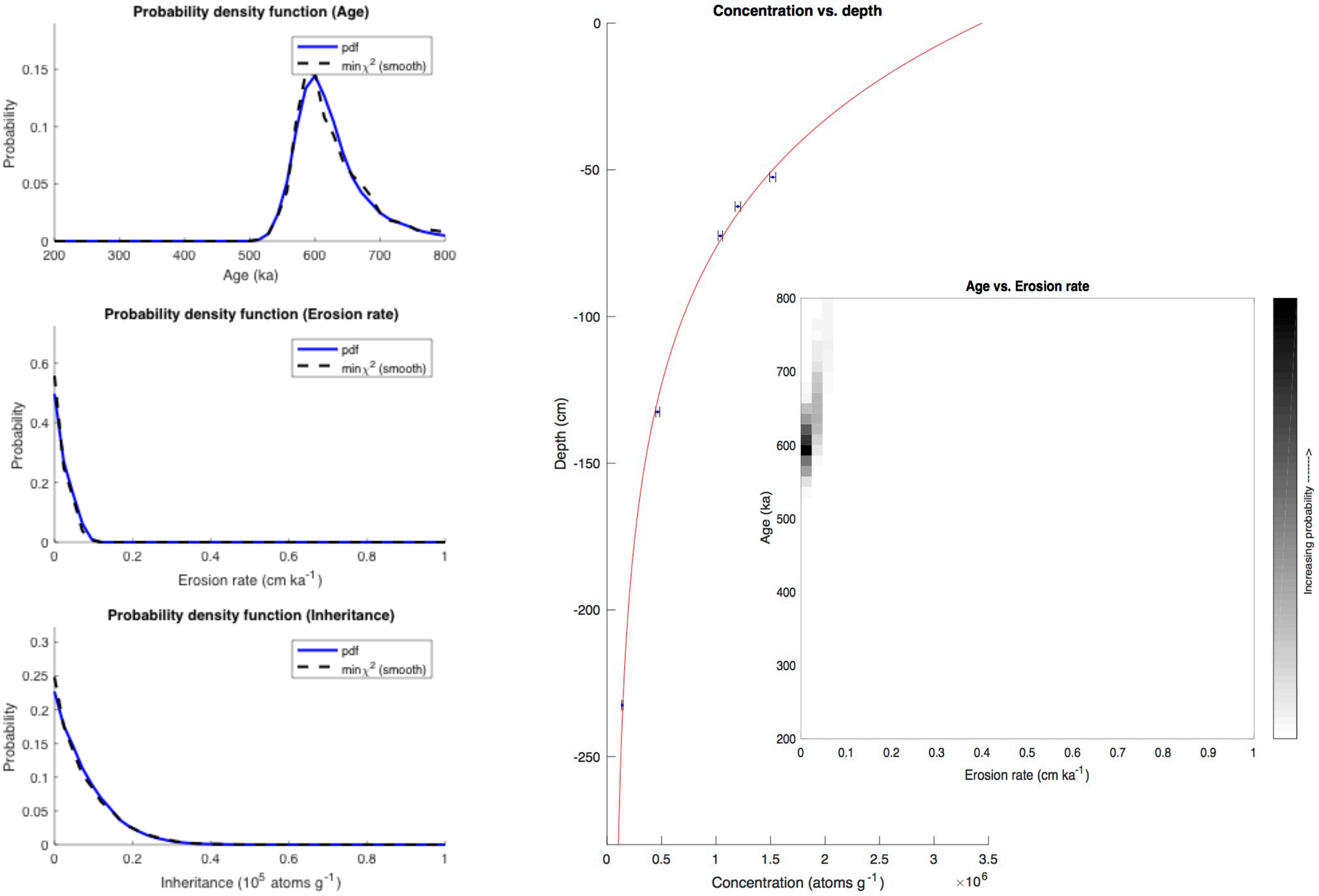

Figure 1: Distribution of the optimal solutions for age, erosion rate, and inheritance for the inversion of Deseado 2 profile ^{10}Be data. The optimal model of ^{10}Be versus depth, resulting from the set of optimal age, erosion rate and inheritance is also plotted. These figures have been drawn from the matlab code supplied by Hidy et al. (2010).

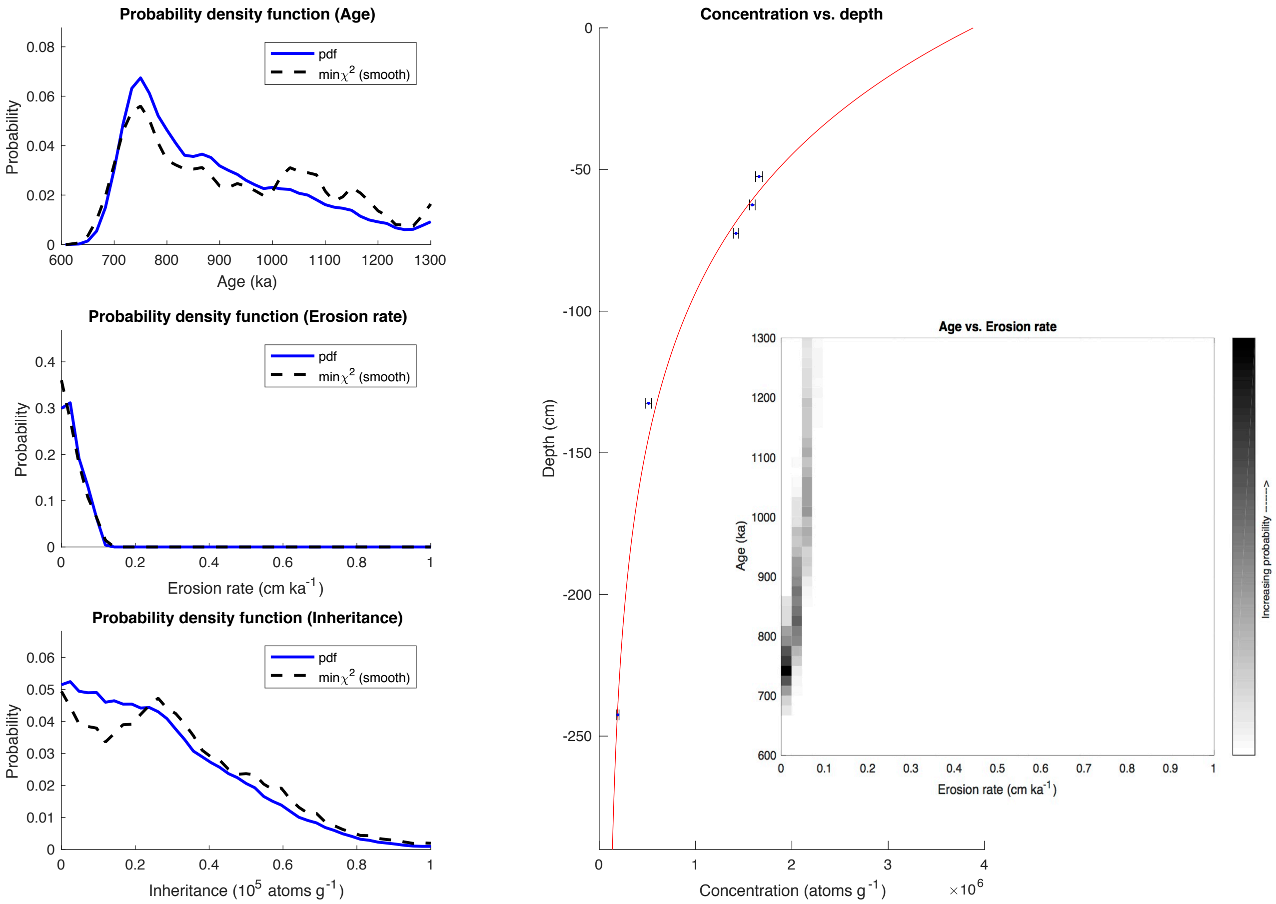

Figure 2: Same as Figure 1 for the Telken 5 profile.

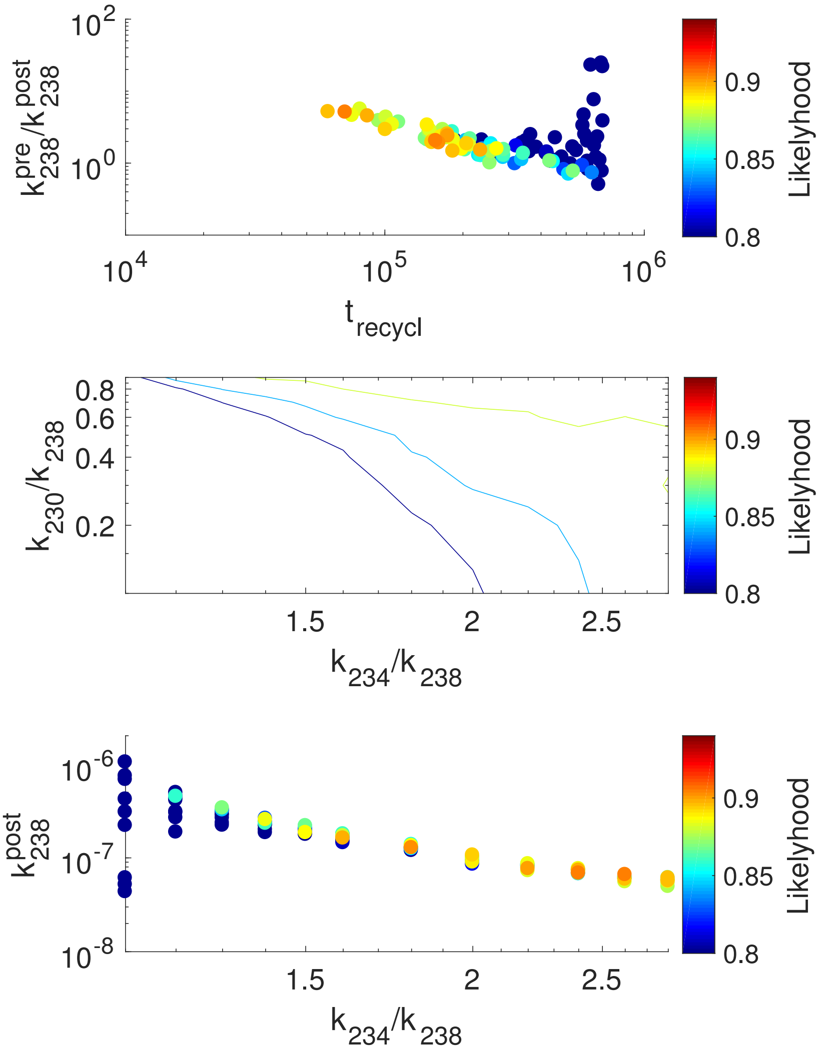

Figure 3: Results of Monte Carlo simulation with $f_\alpha^{230} = 0$. Note that for readibility the colorscale has been changed compared to Figure 6.

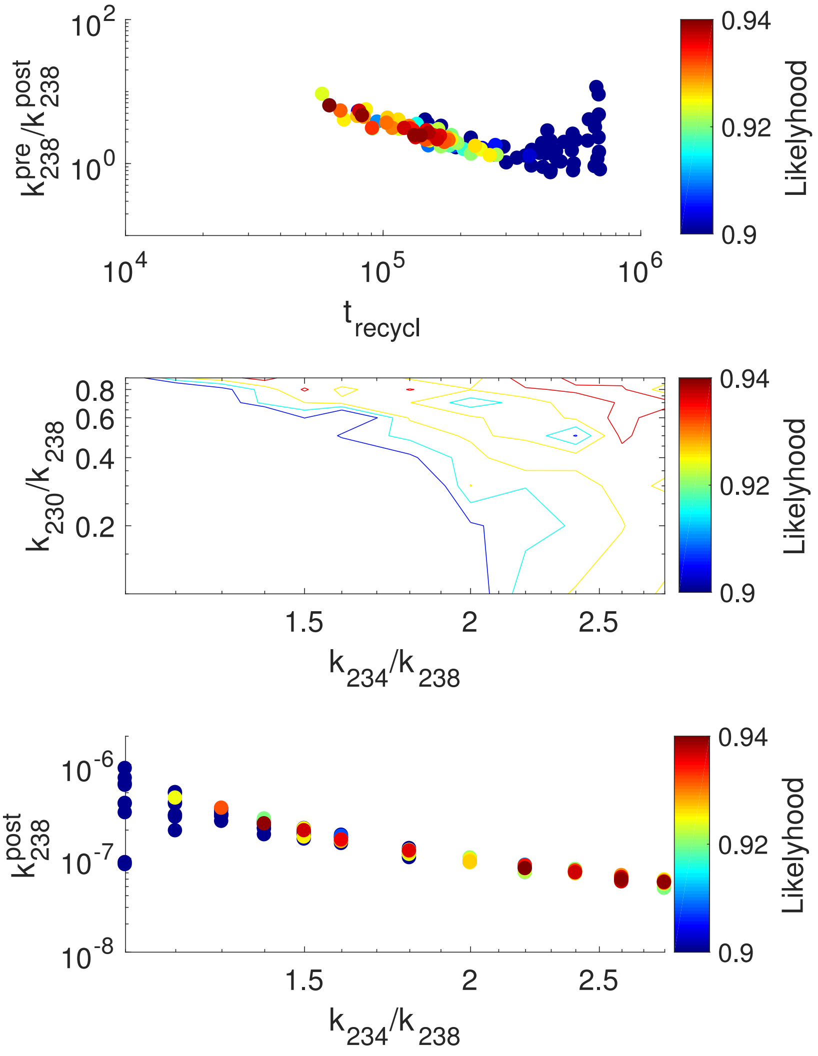

Figure 4: Results of Monte Carlo simulation with $f_\alpha^{230} = \dfrac{1.176 \times f_\alpha^{234}}{2}$ (half of the theoretical value described in section 2.3.1). The colorscale is the same as in Figure 6.

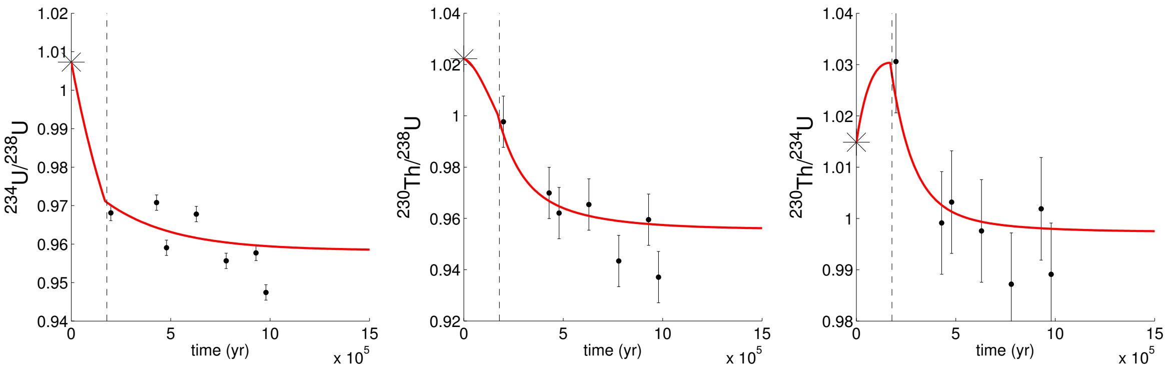

Figure 5: Best fit of the Monte Carlo simulation (red curves). The black points are the data. Errorbars are the external uncertainties. The black vertical dashed line shows the recycling time. This corresponds to a recycling time of 180 kyrs, a ratio $k_{238}^{pre}/k_{238}^{post} = 2.35$, $k_{234}/k_{238} = 1.4$, and $k_{230}/k_{238} = 0.6$.