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Interactive comment on "U-Th and ^{10}Be constraints on sediment recycling in proglacial settings, Lago Buenos Aires, Patagonia" *by* Antoine Cogez et al.

Anonymous Referee #1

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This is a very interesting and appropriate paper for ESD. There are enough new 10Be data and as far as I know (and the authors know) it is the 1st U-Th data and application in southern South American on sediment movement from source to sink, as they say. Hence, this is a novel contribution. I think my comments are moderate to major and not difficult to do.

Some major (or moderate?) comments.

1. One of my most significant comments is that one really needs to be an expert in U-Th series measurements and approach to really follow details of the Methods and Results (not so much Discussion). So much of it may remain largely inaccessible to

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the non-expert, which is a shame, given all their hard-work!!

I am actually not sure how much they can do about this, as the paper is not an appropriate place for a 101 lesson on the U-Th comminution and sediment approaches. On the other hand, I think there are few minor things they can do which I suggest or highlight below (e.g., see figure captions) which will at least help the reader a bit not familiar with these methods. These mainly focus around i) explain figure captions a bit better and ii) perhaos more info in supplement information section (a user friendly flow chart or Table of terms, as suggested below?) iii) some more labels on the figures (see below) and iv) a few places in text can add a few more words (see below)

I should also highlight to the Editor that I am not an expert on the U-Th series and application. I cannot really evaluate this in detail.

2. Some more info is needed on setting and context of samples. i) Specifically some photos of the samples so reader can see the context. This includes photos of the cosmo samples. If possible, they need to provide a photo of the outwash with the moraine behind it (showing how they link); if they do not have such a photo, maybe the closest thing they have. At least one or two photos of the silts they sampled for comminution – are these from a pit? A road cut? No detailed geologic context is provided to the reader to evaluate their results. ii) I think also a more zoomed in version of the map over the sampling area. It is hard to appreciate from their short discussion. See comments below also for Figure 1. iii) Can they provide a strat section, even schematic or simplified?

Minor - also, on map – show Deseado boulder location, since mentioned in the text.

3) Also, I recall there were two telken boulders in Kaplan et al. which were used to derive maximum erosion rates – they are very maximum erosion ages, and very minimum exposure dates, but the authors may want to mention (?) these data because they support i) need to date outwash on these old deposits as they do (and Hein et al do) and ii) the erosion rate they derive below shows these Telken bouder measurements were

indeed maximum erosion rates as Kaplan et al. 2005 stated. More on this below.

4. Apparently, Douglass had measured Deseado boulders in his PhD research that are unpublished, except for abstracts. One abstract that is particularly relevant that authors may want to know about, is a GSA abstract with recalculated erosion rates; these are close to what they derive on the outwash I recall. The abstract is cited in Hein et al 2017. They may want to refer to this, as it is another measurement that supports their finding for very low erosion rates in the area, much lower than the 'max rates' presented in Kaplan et al. 2005. The reference (can be looked up) is GSA Northeastern Section - 42nd Annual Meeting (12-14 March 2007) Paper No. 24-2: CONSTRAINING BOULDER EROSION RATES AND AGES OF MID-PLEISTOCENE MORAINES, LAGO BUENOS AIRES, ARGENTINA (again see Hein paper for references).

5. Can they say if there are any changes in the U-series data over the time of the moraines and sediments listed in Table 3? They sampled a nice profile or transect from old to young moraines, spanning almost 1 million years; this is unique aspect of their study (has this been done even anywhere?). They do not really discuss this at all (unless I missed it). Is there a lot more information here they can highlight or speculate about? For example, are the U-Th results different for moraines from stage 8 and 2, compared with their data on the older telken and deseado sediments Or vice versa? A point is that I am wondering if they can elucidate changes as Southern Andes are eroding down (they discuss Kaplan et al. 2009 mechanism, for example, in this context).E.g., glacial erosive products produced and recycled more and more. . .?

Other, detailed comments corresponding to pages (and providing more info on above comments):

page (p.) 2 line 1 – what do they mean by 'remobilization of moraines' - this sounds catastrophic ! Please rephrase to be more precise in the wording. Do they mean remobilization of fine sediments in matrix? Material they sampled/measured? Moraine matrix?

p. 3. For the part of the study dealing with sediment measurement and findings, it may be of interest to mention that ice sheet glaciations started around 7 to 5 Ma (Mercer and Sutter (1982 i recall)) with tills and supposedly moraines and ice sheet glacial erosion, for several million years, even before the Telken stuff deposited (are there implications for history of fines, glacial rock flour etc?)

line 23 "finally we are able.....sediment history is likely..." I would clarify what kind of sediment – fine sediment? For example, some would include boulders in this context, as the statement is written. I think they mean the type of materials they are working on – if not, their data only apply to the type of sediment sizes they are working on (e.g., rock flour).

p. 4. There is another moraine, the Menucos moraine (Singer et al., 2004; Douglass et al. 2006). Kaplan et al. (2011) recalculated these ages.; they are albeit buried in the last table of the 2011 supplement. The key point is the recalculated ages are around 17 ish (18 to 17 ka), I recall, ignoring obvious outliers.

Line 18 to 20. A clear example in which some photos (2 for example) would of immense help for evaluating what they sampled. A pit? A road cut? Can they provide a strat section, even schematic or simplified?

p.5 see comment about photos

p.6 lines 14+ 1) say what the 'global rate' of Borchers et al rate is at SLHL. 2) how does global rate of Borchers et al compares with the local rate in Kaplan et al. 2011 and whether the difference in rates will mean for their older results. For younger features, should not matter too much, but once you get to Deseado and Telken age, even small differences between Borchers et al and Kaplan et al. rates could be significant given non-linear age equation.

I bring this up – in part – because I am actually wondering if they will get slightly better agreement with Ar/Ar and/or marine oxygen isotope comparisons; I cannot recall exact

C4

#s, but I recall the Borchers et al. rate is higher than that in Kaplan et al. which is for Patagonia. It is easy for the authors to estimate the difference – on the online cronus calculator Balco provides 'alternative versions for 2.2. Although still v.2.2 it is good enough to see the effect of using a slightly lower PR (Kaplan et al. 2011), if correct.

p. 7 to 11 – see comment above about U-Th analyses.

p. 11 section 2.3.4. if they can give one sentence on why this matters, to the non-expert, that would be helpful.

p. 13. As mentioned above, it is relevant to mention the Douglass et al study, albeit just in GSA abstract form, which has low erosion rates on par with their values. It is important for them to point out that this is much lower (and more realistic) than that boulder erosion rate presented in Kaplan et al 2005, which presented maximum rates. Albeit Kaplan et al. 2005 and douglass et al were for moraine boulders (may be slightly different than their data given possibly more exhumation on the moraines).

p. 14 line 8 and 9 (last sentence before new section). Regarding the sensitivity tests, I suggest they may want to mention that the global rate in Borchers et al vs local rate in Kaplan et al., although very small, does not make a difference given a non-linear age equation. If the "global" rate in Borchers et al. is slightly higher (I recall), which is what is listed on the Cronus 2.3 site. The importance is that with a higher rate they get slightly lower ages, especially for Deseado and Telken time.

p. 15. Line 13 Section 3.3 title For non-experts, what do they mean by ': a 3-dimensional problem"

This is another example how a little bit more info may make these aspects of the paper a little more accessible to the general ESD audience.

Line 16. What do they mean by youngest moraine sample – which sample (refer to which sample in table)?

p. 16. glacial periods are much dustier – with likely much of the dust coming from

Patagonia (lots of literature on this). Perhaps 1 or 2 sentences on what such dust inputs may be bringing in, in the context of their results. Is this another implication they can highlight of their U-Th results and findings?

p. 17. Line 18. Add something along the lines of "slight changes in scaling factors (see methods) do not affect this finding."

Line 18 – the 476 ka – is this recalculated? I assume it is from the 2005 paper, but please state so.

Line 24 before "Smedley" a word or two missing or open parentheses.

p. 18. Top line 1 – spelling after the word Telken Line 27 grammar problem

p. 19 Line 14-15. First two sentences - awkward writing.

p. 20. per comment above, sorry, perhaps my non-expertise, but, can the authors say if there is a change in the U-Th data between Telken and Fenix moraines. A change in time of weathering rates? The relevance of the issue is testing the idea they discuss, in Kaplan et al. 2009. Is there a change in results and thus sediment transfer times/comminution age over the 1 Ma as valleys are excavated and Andes erode down?

Lines 17-19. Starting with "this is exacerbated..." I do not understand this sentence – it is not clear. The authors need to clarify.

Line 23. What do they mean by 'moraine sediment.' That is very broad. Does this also apply to boulders? Or just find matrix in moraines? Please clarify (a similar question was raised earlier about the whole moraine being remobilized).

p. 21. Line 24. I think I know what the authors mean, but as written, not recorded or not preserved is same thing. Rephrase to, not recorded because not preserved, or do they mean not preserved or ice did not reach this far? Something similar?

Table 1. It is becoming customary to also provide AMS ratios and carrier added (9Be).

Given that (I think) it is standard enough to do this now in cosmo literature, that I have to insist these two columns be added to the table.

Also, in caption, please remind reader of AMS standard used, given it is not common (except at ETH).

FIGURES Figure 1. It is difficult to evaluate fully the morphostratigraphic relations that are essential for interpretation of data from this figure: 1) need some photos associated with these maps – see comments above. This is especially so for the outwash linked to the moraine – cannot appreciate this from the map. Otherwise need to say perhaps not directly related to the specific moraine – does it actually really matter for their main findings if they establish this? that is, deseado outwash is deseado outwash whether specifically linked to a specific crest in Singer et al, 2004. 2) I suggest one more panel really zooming in on the key area where the crests, outwash, and samples are. A panel D. This could be in the SOM if there is not enough room in the paper. The photos could also be in the SOM – just add one figure of several photos.. Any strat sections, with where the samples are from, that they can provide in SOM? I think it is always best to have the photos in the main text if there is space. However, if there is not enough space, at least to have them in the supplement info as a figure. 3) explain CDI and SPI in caption. SPI is obvious, but not CDI ? there are lots of glaciers in C. Darwin– what is specifically being highlighted and why for CD? the biggest ice mass in CD? 4) there is an error in the caption – the transect is in panel B (it says panel C, but this is in B)?. 5) after "[c]": add "[c] Inset shows a west-east transect. …..." 6) For cosmo ages, it would better to make the symbols the same colors as those on figure 2. Easier for the reader not familiar with the area. I would also make the 2 outwash symbols as squares on Figure 1, just like on figure 2. 7) plot Deseado boulder that you refer to, from the literature (is from Kaplan et al. 2005 ?)

Figure 2 1) maybe also plot here the Deseado boulder age (without erosion) that refer to? If do plot it, say it is a minimum age. Up to authors though whether they think it is best to plot the boulder cosmo age on figure 2, or it would be too messy. It would

highlight again the moraine oulder ages too young. 2) Could all Deseado 2 ages be minima? Not just the 293? Deseado 1 has such a nice tight cluster, hard to envision being too minimum, but Deseado 2 is more scattered and only 2 ages. 3) I suggest showing the full LR 2005 curve. It is relatively easy to do, it does not take up much room and would be more informative than showing positive Stages. It would convey more info such as stage 8 not being a big global glacial maxima (cf., Hein et al.) 4) in caption, say what the effect is of using local PR versus global PR of Borchers et al, if significant ? see above comment?. Although not much for younger moraines, given the age equation is non-linear, it can add up for older Deseado moraines?

Figure 3. 1) This plot is difficult to digest for the broader readership of ESD. Perhaps add some labels. For example, in the bottom 3 quadrants, can they add labels to all or some of the quadrants to summarize what we are looking at? In the top panels maybe also some more labels would help – what is the blue line? What are the red lines? It is explained in the caption, but, per my comment at top of review I am just trying to think of ways to make this figure more accessible to all readers.

2) Also, it is not clear – are these all hypothetical – or based on the monte carlo simulations – it is implied so ('results' mentioned in caption), but it is not specifically stated, and obvious to non-expert. 3) 4th line from bottom – 10Be ages – please explain which 10Be ages – reader cannot tell simply from the figure. 4) third line from bottom – "Weathering intensities are lower after moraine deposition" – how do you know this? That is, please explain from the plot how this is known. Or show visually with suggestion above to add labels.

Figure 6. Needed to explain a little better for non-experts – see comments at start of review. For non-experts, what is likelihood signify? Instead of Trecycle – spell out? Maybe a table in the SOM of all of these terms with a brief explanation, for non-experts? In panel A for example, they may add some info to the plot itself – some labels of what we are looking at. For example, what does the bend and dark vertical-aligned purple dots mean? Maybe a few labels on this plot and the bottom plot would make this more

accessible to nonexperts in U-Th approach.

Supplement information.

Section 2. Given the prominent role the profiles and monte carlo simulation play in the paper - this section needs to be expanded to explain: 1) what the monte carlo optimization is and how it is done? Some of this is in the main text, but more details in the context of the Supplement are appropriate here in my opinion. 2) a paragraph (at least) explaining what we are looking at on Figures 1 and 2. What are these panels? The caption should refer to each panel. Or the text. Please explain each panel in more depth and/or in caption. The right panel – this is a key figure. Explain more – what is reader looking at? Not much is needed, perhaps just a longer caption, but more is warranted in explaining Figures 1 and 2 in the context of supplementary information and simply to describe what the reader is looking at, which are some of the key results discussed in the main text.

Figure 3 – in caption, for non-expert, can they add one more sentence saying what f230 = 0 means? The authors also may want to add some labels along the lines of the comment above for main text figures.

Figure 5. Explain specifically where time comes from (e.g., U-Th dates associated with moraine/outwash dating....and so on, see table 3)

Per comments above, add photos and any strat sections. I would put the photos in the main text if there is room.

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