Earth Surf. Dynam. Discuss.,
https://doi.org/10.5194/esurf-2017-76-RC2, 2018

Interactive comment on "Tracking the ^{26}Al/^{10}Be source-area signal in sediment-routing systems of arid central Australia" *by* Martin Struck et al.

Anonymous Referee #2

Received and published: 8 February 2018

My overall thoughts on this paper is that it is a well-organized, systematic, and mostly-clearly communicated study that has broad-arching implications for our understanding of how to approach and interpret cosmogenic data collected from quiescent continental interiors. I believe this study will make for an important contribution to geomorphology and will be very useful for those of us carrying out work in similar settings. I structure my review as suggested by the journal below:

1. This paper directly addresses relevant geomorphic questions, "How well do erosion signals at distal downstream sampling sites reflect source-area geomorphic processes in arid, low-relief, continental interiors?"

2. This paper comprises a large and important dataset of 29 new 10Be catchment-averaged erosion rates from an otherwise undersampled type of landscape: tectoni-

cally quiescent, low-relief, arid, continental interiors. The authors pair the 10Be concentrations used for deriving erosion rates with 26Al from the same samples to observe how the 10Be/26Al ratio is affected by geomorphic processes (sediment storage and admixture of stored sediment) as it is transferred from source to sink. The authors successfully synthesize multiple datasets of cosmogenic data and luminescence data from a variety of potential sediment sources to explore how environmental signals carried by eroded sediment are altered during sediment transport.

3. The authors reach a number of conclusions. Mainly, (1) that 10Be concentrations in distal downstream sediment reflect the 10Be inventories of their source area lithologies, (2) that burial signals from 10Be/26Al ratios increase downstream as rivers mix sediment from long-term storage sinks (dunes, fans, pavement, floodplain) with actively-transported fluvial sediment, and (3) that erosion rates derived from 10Be measurements in low-relief, arid, continental interiors with large amounts of sediment storage and episodic sediment transport should account for the cumulative burial signal prior to arriving at any conclusions about source-area landscape dynamics.

4. The scientific methods and assumptions are valid and clearly outlined. Moreover, the authors very clearly set up multiple working hypotheses and collect samples, which allow them to very clearly assess the viability of each hypothesis.

5. The results are sufficient to support the interpretations and conclusions made by the authors. Just as importantly, the manuscript is written well-enough, and the figures are drafted accordingly, that the reader is able to follow the authors' lines of reasoning easily.

6. The authors describe in sufficient detail the well-known and often-used technique of applying cosmogenic 10Be and 26Al measurements to address outstanding issues of geomorphic importance. Table 2 provides all necessary sample location information (coordinates, elevation), the sample mass, nuclide production scaling factors, 9Be and 17Al carrier masses, and the AMS 10Be/9Be and 26Al/27Al ratios. The manuscript

documents measurement and analytical uncertainties, the AMS standard materials used, the production rate used, the erosion rate derivation method used, the half-lives assumed, and the locations of sample measurement. Having never performed TL measurements myself, I am uncertain of how detailed the TL community prefers measurement details to be documented, but the authors cite appropriate methodological literature.

7. Yes. Very clearly up front, the authors cite numerous other studies that present findings showing how cosmogenic nuclide abundances can increase, decrease, or stay the same with distance from their source area. The authors also very clearly document important studies that have enhanced our understanding of what cosmogenic nuclides measured from stream sediment in rivers that drain active mountain belts tell us about source area dynamics, and the authors clearly depict in Figure 1 how their work will improve our understanding of what environmental signals are carried by CRNs in rivers draining low-relief, inactive, continental interiors.

8. Yes. The title aptly describes the content of the paper.

9. Yes. The Abstract is concise and complete. A few comments here, though. Line 4 of Abstract mentions "the factors responsible" but the authors do not say responsible for what? The reader is left unsure. Line 10 of the Abstract mentions "downstream-increasing minimum cumulative burial terms," which is a mouthful and should be simplified considering the authors do not focus much in the paper itself on the notion that burial times are "minimum-cumulative."

10. Generally, yes. This is a fantastic example of a clear, direct, and easy to follow research study. I was able to mark exactly where the authors state (1) the knowledge gap, (2) the working models, (3) the hypotheses being tested, (4) key results, (5) significance of the results, and (6) why the field area was able to address the questions being asked. I did find the thermoluminescence methods seemingly out of place, since nowhere prior to Section 3.2 was it mentioned that TL was part of this study, and while

the TL results are important for interpreting observations (Page 9, Line 34 – Page 10, Lines 1-3), they seemed to come out of nowhere and disappear again until the Discussion. I suggest that the authors more clearly state why TL dating was needed up front and incorporate the methods more seamlessly into the manuscript.

11. The language was fluent and precise. However, I found myself confused between the use of the word "downstream" throughout the manuscript and the presentation of data in Figures 5 and 7 (middle panels), which was plotted as "distance upstream." It took me a while to realize that by reading each of the panel-sets in Figures 5 and 7 from Left to Right, I was following either the 10Be inventory decrease or the burial signal increase from source to sink. That could be made clearer in the manuscript text to help the reader follow the clever way the data were presented. The same confusion came with the plots of the "fraction of bedrock and colluvium" because 100% was on the left-hand side of the x-axis. Again, this is because there is a greater % of bedrock in the source area, but it took me a few attempts at reading the figures before I grasped why the authors presented their data in this way. In sum, I think the authors should be more specific in the manuscript or figure caption to help the reader digest their well-thought-out plots.

12. Mathematical formulae: There were no formulae presented in the manuscript. Symbols: In Figure 1, "Q" is used but never defined. Please define. Abbreviations: I noticed no confusing abbreviations. Units: I notice that the nomenclature of some units is inconsistent throughout. For instance "atoms g-1" compared to "m/M.y."

13. Clarifications: 13a. P.1, L.4-5: "...identify the factors responsibe." Responsible for what?

13b. P.1, L.20-21: Sentence starting with "The timescale..." I think the wording here is fundamentally backwards. Sediment transfers occur at their own pace, regardless of how we measure it. But how we measure it determines the timescales over which we can make inferences about sediment transfers. I agree with the following sentences, but please consider rewording here.

13c. P.4, L.5-8: Have the authors considered how such long-wavelength deformation might affect CRN inventories?

13d. P.4, L.21-26: This is repeated from further up in the section. Please consolidate.

13e. P.5, L.2: "…respectively." Which classes were assigned to which domains? It does appear to be clear. Please revise for clarification.

13f. P.6, L.3: Section 4.1 only addresses 10Be abundances, and does not mention 26Al. I suggest the authors either detail how the 26Al abundances change with sample position downstream as they do with 10Be (difficult for a reader to do this by looking at the table only), or remove "26Al" from section header.

13g. P.6, L.25-26: Considering that one of the main points of this study is to demonstrate how incorporation of buried sediment in downstream catchments affects interpretation of upstream erosion rates, and considering that the authors suggest a 2-12x change in erosion rates after burial is accounted for, the range of erosion rates shown here appears to show a less-severe change to modeled erosion rates. In fact, I look at Table 3, and I cannot find a sample from the Neales catchment that shows a 12-fold disparity in erosion rate before/after burial is accounted for (as is said on P.11, L11). This is a point I feel that the authors must make more clear or obvious to the reader prior to publication.

13h. P.6 L.28: Section 5.1. I would really like to see a figure that clearly shows the similarities between fluvial sediment inventories and bedrock inventories. Given that this is the authors' primary conclusion, I find it odd that this is not more clearly shown.

13i. P.7, L.20-26: I find the wording here to be inconsistent with the values presented. The authors state that (1) the ridges and hillslopes of the MacDonnell Ranges have similar and low 10Be abundances, (2) bedrock feeds headwater streams directly, but then (3) headwater streams exhibit a wide range of 10Be inventories, which reflects

bedrock composition. How can the ridges have similar and low 10Be abundances while at the same time feed a very wide range of 10Be directly to the streams? This is where the conglomerate and the quartzite-sandstone come from, which have distinct 10Be abundances, so I agree with the authors that the wide range in 10Be inventories reflects this, but then the ridges of the MacDonnell Ranges cannot have similar and low 10Be inventories. This seems easily resolved by rewording and clarification.

13j. P.7, L.28-29: The authors suggest that a rise in 10Be amount coincides with a shrinking fraction of bedrock and growing fraction of sediment cover, implying slight burial/storage? But in this case, couldn't an increase in 10Be also signify a decreasing legacy of the rapidly eroding conglomerate to the increasing signal from the more slowly eroding quartzite-sandstone from bedrock and hillslope materials?

13k. P.9, L.5: Not sure why Portenga & Bierman (2011) is cited here. I'd remove or clarify.

13l. P.11,L.11: The authors here mention a 12-fold disparity in erosion rates if burial is or is not accounted for in the Neales catchment. I still do not understand where this 12-fold statistic is coming from. I see on Figure 7 that there is a 12-fold change in the apparent burial signal from the 10Be/26Al ratios for both the Macumba and Peakes/Neales catchments, but the erosion values in Table 3 are not 12-times greater or less after burial is accounted for than when burial is not accounted for. Perhaps I am not understanding the authors' interpretations here, but I think this requires clarification prior to publication.

13m. Figure 2 shows the locality of Oodnadatta and they refer to the Oodnadatta Tablelands in the manuscript, but I am not sure if the Oodnadatta Tablelands are the low elevation area around the locality of Oodnadatta, or if the Tablelands are formed by the silcrete mesas? Please clarify, or show with words on the map. Also in Figure 2, the Musgrave Range is labeled, but never mentioned in the text, but its inclusion made me wonder how sediment sourced from the Musgrave Range might impact cosmogenic data from the Macumba River catchment?

13n. Figure 3: Great images. Panel A should have a N-arrow on it since Figure 2 suggests the range strikes E-W, but it is shown up-photo-down-photo here. Panel C inset should have a scale bar; at first glance, I thought this was the sand collected, not the pebbles of the desert pavement.

13o. Figure 5: Please label each of the figure subsets with the catchment name. I found myself flipping back and forth in order to remember which catchment was which. Or maybe use the same map insets you use for Figure 6? Lastly, the authors say that Figures 5A, D, and G show apparent burial ages, but only 10Be concentration is shown, not ages. Wording of the text should change to be consistent.

13p. Figure 7: Please label each subset of figures with the catchment name.

14. The number and quality of references is appropriate.

15. Amount and quality of the supplementary material is helpful and appropriate.

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