Earth Surf. Dynam. Discuss.,
doi:10.5194/esurf-2017-18-RC2, 2017

Earth Surface Dynamics
Discussions

Interactive comment on "^{10}Be systematics in the Tsangpo-Brahmaputra catchment: the cosmogenic nuclide legacy of the eastern Himalayan syntaxis" *by* Maarten Lupker et al.

Anonymous Referee #2

Received and published: 6 May 2017

Lupker and colleagues show 10Be concentrations in river sand along the Tsangpo-Brahmaputra river. This river crosses the Namche Barwa-Gyala Peri massif, uplifting and eroding at a higher rate than upstream and downstream. Converting the riverine 10Be concentrations in mean denudation rates of catchment above each sampling point, they observe that the peak of denudation rate is shifted almost 500 km downstream from the uplift hotspot. Without knowing that the Namche Barwa-Gyala Peri massif was an area of high denudation rate, the 10Be-derived denudation rates would have led to a wrong zonation of the denudation rate in the eastern Himalayan syntaxis. Lupker and colleagues argue that this mismatch arises from a delay imposed by the abrasion of coarse bedload sediment. Indeed, sediment generated in the hillslopes of

the uplift hotspot may include a significant fraction of coarse material > 1mm. Yet, the 10Be concentration is measured in the [0.5-1] mm fraction. A long transport distance is required for the coarse material to be crushed into the [0.5-1] mm fraction. Using a simple model based on estimates of abrasion rate and mass balance of 10Be fluxes, Lupker and colleagues show that their interpretation is likely.

These data have a significant impact concerning the determination of catchment-scale denudation rates derived from cosmogenic nuclides concentrations. They show that the dilution process, first proposed and discussed by Belmont et al. (2007), can strongly alter the mapping of denudation rate in catchments. In turns, this study opens perspectives of using riverine cosmogenic nuclides to quantify abrasion rates in mountain rivers. The paper is well written and the data and model support the conclusion. That said, I have several concerns I would like to be discussed.

1- In Figure 3, the mean denudation peak (circles) occurs at point 9, almost 500 km downstream the high uplift rate area. Nevertheless, there is a significant variability in 10Be concentrations between individual samples at the same site. In particular, at point 7, two individual measurements (crosses) show high denudation rates, as high as the peak at point 9. The average (circle) at point 7 is much lower because there are 2 individual samples corresponding to low denudation (why is not the mean at equal distance between the two high and two low values ?). How do you interpret this variability at point 7 and the high denudation rate (low 10Be concentration) points ?

2- The results are presented on the form of upstream mean catchment rates. Showing the mean denudation rates of nested catchments, in particular between points 3 and 4, would help see the discrepancy between the high uplift rate area and its low mean denudation.

3- The model is simple and its outcomes seem conclusive. However, how does the predicted denudation pattern change if the true drainage areas are taken into account instead of assimilating the catchment to a rectangle ? I think that the model outcomes, presented as a synthetic case study, is demonstrative. Nevertheless, this model (the best fit one for example) would deserve to be compared to the data along the river profile.

4- I was very surprised that the model prediction does not depend significantly on the product fg x fas which determines the amount of coarse material provided by the high uplift area to the river sediment downstream. It is very striking that adding 5% or 40% of this material to the [0.5-1] mm fraction leads almost to the same result (Figure 7d). Is this result robust for different abrasion rates k ? How is it possible that adding to the [0.5-1] mm fraction only 5% of the coarse material delivered by the high uplift area has such an impact ? On Figure 7c, I presume that the legend is wrong, namely that the downstream actually increases with the abrasion rate k, isn't it ?

5- This study demonstrates that the sand fraction provides a low estimate of the denudation rates in rapidly eroding area. This echoes suggestions in previous studies (e.g. Belmont et al., 2007; Aguilar et al., 2014; Carretier et al, Quat. Geoch., 2015), and demonstrates it clearly here. The following question may be beyond the scope of this paper, but broadly speaking, should we sample and crush together all the bedload grain sizes (including cobbles) to get a better estimate of the denudation rate ?

Specific comment by lines.

Page 2 line 35 You may want to cite Belmont et al. (2007) who discussed the effect of pebble abrasion and the dilution effect.

Belmont, P., Pazzaglia, F., Gosse, J., 2007. Cosmogenic 10Be as a tracer for hillslope and channel sediment dynamics in the Clearwater River, western Washington State. Earth Planet. Sci. Lett. 264, 123e135.

Page 5 line 18 The latitude Stone (2000) scaling scheme for muons is obsolete. The relative contribution of muons and neutrons varies with elevation. Could you specify if you took this into account ?

Page 5 line 34 The absence of incision could mean that there is some addition of floodplain sediment and 10Be concentration to the river bedload by lateral erosion. I guess this would not change your results, but you may discuss this.

Page 9 line 7 Please justify why this recent sediment input is unlikely to dominate the sediment budget.

Page 10 line 2 Do you consider that sand is mainly in suspension ?

Page 11 Please justify the range of tested abrasion parameters.

Page 11 line 31-32 I do not understand this sentence.

Page 11 line 34. I think you should not too much worry about the absence of systematic correlation between grain size and 10Be concentration in this case. This comparison concerns very fine fractions, with a lot of different possible origins. It is possible that the by-products of abrasion that affect the riverine 10Be signal downstream derives from the abrasion of large pebbles and cobbles. Obviously you can not prove this because you do not show 10Be concentration of this fraction, but Carretier et al. (Quaternary Geochronology, 2015) for example, showed a systematic low 10Be concentration in 10 cm pebbles in several catchments along the western Andes, whereas the 10Be concentration of 2 cm gravel is either lower or higher than the sand fraction. In an Himalayan catchment, Puchol et al (2014) showed lower 10Be concentrations in [0.47-4] cm pebbles. This remains to be proven, but if rapidly eroding areas provide a large proportion of sediment as large pebbles and cobbles, systematically less concentrated in 10Be, then this may be the abrasion of that coarse material that controls the dilution process downstream, and not that of the smaller fraction. If true, knowing the size distribution of material eroded from the hillslopes would be essential to quantitatively interpret the 10Be riverine signal in terms of abrasion rate. Again, it is clear that you cannot provide more information about this debate with your data, but it may be worth to think about it.

Page 16 line 30 takinG

Figure 3: localize the Namche Barwa-Gyala Peri massif on that profile and the others.

Figure 7c: wrong legend.

Figure 10: I do not fully understand what are the two red lines, the red circle and the red zone between the two lines. The caption indicates incorrectly that the x axis is the upstream drainage area whereas it is the downstream distance. “exists” → exits.

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