

## ***Interactive comment on “Graffiti for science – Erosion painting reveals spatially variable erosivity of sediment-laden flows” by A. R. Beer et al.***

**Anonymous Referee #1**

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In the submitted manuscript Beer et al propose a new method for documenting spatial distributions in bedrock erosion via painting of bedrock surfaces. The authors suggest that paint is eroded by impacting sediment, such that areas of eroded paint correspond to areas of bedrock erosion, and compare their observations of eroded paint to repeat terrestrial laser scans.

To my knowledge, this is a new technique which has not been previously documented, and the authors show compelling results where the spatial patterns of eroded paint can be used to infer both variations in sediment impacts across a channel, as well as temporary aggradation of the sediment bed which can occur during floods. Erosion monitoring via painting appears to be a useful and easily applicable tool which can

C1

be of use in a variety of erosion studies, and as such, this manuscript deserves to be published. However, I have a few general comments which should be considered before published the final version.

Major comments

1. The repeat photographs showing eroded paint do an excellent job of documenting erosion of paint via sediment impacts. However, I found the comparison with the TLS scans quite useful for making the connection that erosion of paint tracks with actual bedrock erosion. As this is intended to be a proof-of-concept methods paper, I think the paper could benefit from more comparisons between the TLS scans and photographs. For example, it could be useful to show some type of quantitative comparison between the eroded paint and documented bedrock erosion from the TLS scan (if the photos can be mapped over the TLS scans, then one could, for example, directly compare the areas of eroded paint with bedrock erosion from the TLS scans). For the paired TLS scan and eroded paint pair presented, it would be useful to show a TLS pair which corresponds to the photograph dates for painting (if such a TLS pair exists). Additionally, showing other TLS pairs which correspond to the eroded paint at different locations in the gorge would be worthwhile.

2. This appears to be a companion paper to a manuscript the authors have in review at JGR – Earth Surface. I have not seen this other manuscript in review, but from the citations listed here, this other paper appears to present more of the science and implications associated with documenting spatially-variable erosion, while this manuscript is focused more on methods. To that extent, there's large portions of the discussion section (e.g., section 4.2) as well as other parts of the paper that address some of the process implications and general science questions which may be more appropriate for the companion paper. Removing such sections from this paper would shorten the manuscript length and help to keep the focus on presenting a new method rather than discussion of science. Minor comments

C2

1. The authors frequently use the terminology which is either not explicitly defined or can have an ambiguous meaning. For example, the terms “tools effect” and “cover effect” should be defined since they won’t be obvious to all readers. Furthermore, I think it is more straightforward to simply describe the actual processes going on rather than using terminology, so in many places use of the term “tools effect” could be replaced, for example, with “sediment impacts”, and similarly “cover effect” could be replaced with something like “shielding of bedrock by deposited sediment.”

Often times erosion is mentioned, but it is unclear if this is meant to be erosion of paint or erosion of bedrock. Also, I think the authors use the term “erodibility” to refer to erosion of a material (i.e., bedrock erosion or erosion of paint), while “erosivity” refers to the ability of a sediment-laden flow to erode material, but I don’t think these terms were explicitly defined.

2. The writing in the paper is acceptable and the paper is readable, but there are many examples throughout the paper where the writing can be made more concise and superfluous information could be removed to reduce the overall manuscript length. I’ve indicated some of these in the technical comments below, but there are more throughout the paper.

3. The documentation of aggradation during floods is cool and perhaps worth also highlighting in the abstract of the paper and emphasizing as an important benefit of this technique.

Line-by-line comments (no response needed)

Throughout the manuscript and the figures all dates should be listed in international format, i.e., 29.08.2012 should become 29 August 2012.

Page 1

L5 and L8 – Suggest removing the terms tools and cover effects from the abstract, and instead replacing with sediment impacts and deposited sediment since these are

C3

non-technical terms, and tools/cover effect should be first defined.

L13 – The ‘several interacting processes’ are not mentioned, which makes this sentence awkward.

L14 – Suggest ‘hydraulic shear detachment of bedrock grains’ and ‘plucking of bedrock blocks’ or something similar for clarity.

L21 – Suggest ‘downstream directed erosion of bedrock which protrudes into the flow’ (I was confused when I first read this sentence, I don’t think I’ve ever seen the term ‘channel clearance’ before).

Page 2

L5-12 – This paragraph is introductory material, not methods material (at least in my mind. . .).

L6-8 – Suggest removing “Besides colouring such tracers” and combining the two sentences for clarity.

L15 – “Defined vantage points” is maybe better as “repeatable vantage points”

L17 – Are “retrievable features” benchmarks? If so, suggest a change of terminology

L19 – This is a claim that will be later documented in the paper, but it is written here as fact. For the methods, I suggest writing something like “We suggest that the spatial pattern. . .”

L24 – TLS should appear in parentheses, e.g., (TLS).

Page 3

L1-3 – Suggest, “We tested the ability of paint to record spatial variations in bedrock erosion by comparing photos of worn paint to quantitative erosion analyses based on repeat high-resolution TLS surveys.

L5 – Suggest starting with at least one or two general sentences describing the erosion

C4

that occurred in the gorge rather than jumping right into the specific details.

L8 – Here and also on L11-12 the writing is a bit ambiguous. I think you mean the highest flushing height recorded over the entire period was 2.6 m, the mean height averaged over all the events (including the time discharge was building up and waning down) was 1.3 m. Also, for the purposes of this methods, proof-of-concept paper, I'm not sure all this information is needed and some of it could be summarized in a table (and I imagine a lot of it is reported in the JGR paper), so some of it could be removed here to shorten the manuscript.

L10 – Can you provide some explanation why it is likely that there were three more flushings? Did the power company report three flushings but no equipment was installed to measure the water flow at the time?

L23 – The word choice “interesting” here is not a very useful word as it is subjective and does not describe any of the actual patterns.

L26 – Is “UFCS-form evolution” a term that is commonly used in the literature? This seems like imprecise English to me, maybe try something like “The eroded paint on the boulder showed patterns that are typical for forming and upstream facing convex surfaces...”

Page 4

L1 – Suggest sediment flow should be sediment impacts.

L7 – I would add water dissolution in addition to shear detachment.

L10-15 – I see the erosion painting method as a quantitative measure of the spatial distribution of sediment impacts, so I think this is something you could include if you wanted to mention a quantitative ability of the method. Agreed that erosion measurements from the method are qualitative.

Page 5

C5

L4-5 (and elsewhere) – I suggest reporting erosion rates in either mm/yr (instead of mm per 2 years, which is quite uncommon), and these should be instantaneous erosion rates based on the total time of flushing. Because the gorge's hydraulic regime is not natural, it makes more sense to me to normalize erosion rates by the total flushing time, as the flushing time can vary from year to year.

L24-25 – I found it odd that shear detachment of paint by bubbles was mentioned here and not discussed. If this is to be brought up, the authors should discuss to the extent possible whether or not this mechanism led to erosion of the paint. My interpretation is that there are areas which were inundated with water but do not show erosion, such that the water alone is not able to erode the paint.

L32 – This is the only time in the manuscript where the possibility of varying sediment size is mentioned. If there is some data on this, it could be useful to mention earlier in the manuscript (this doesn't need to be in a lot of detail, but when describing the different flushing heights, one could also mention how the size of sediment supplied to the gorge could have changed).

L33-35 – This is a nice example of where the authors could show more TLS data as an example of when TLS measures no erosion but painting shows sediment impacts.

Page 7

L4-5 “who showed” should be “which shows”

L7 – The phrase “From a more local perspective” doesn't really make sense to me in this context. Also, here is an example of where erodibility and erosivity need to be explicitly defined.

L11-13 – Abrasion mills can also be used to explore variations in “erosivity” by changing the flow velocity, the sediment size, or the sediment load, so I find this comparison a bit unfair or perhaps misleading.

L26 – I think the study here already demonstrates a test of relative erodibility of paint

C6

by water, doesn't it?

L32 – Hasn't erosion of alluvium already been studied using paint in the Dietrich et al (2005) and Surian et al (2009) refs already cited? Or did you have something else in mind (if so, please elaborate).

Figure 2

- Again, units of mm/2year seem inconvenient to me. Suggest changing as mentioned above.

- 2E – Instead of having an x-axis on the bar chart, I suggest simply listing the date interval over which each bar corresponds to.

- 2D and E – Are these peak flushing heights?

- In the caption for (F) please list the exact date range rather than over “two years 2012-2013”

- 2G - Please report width of bin measurements are averaged over.

Figure 3

- The numbers indicating (I think) height in cm of different features along the painted stripes are not clear. The unit should be given and I also suggest adding a double-pointed arrow to make it totally clear over what area the number applies to.

- Showing the average or peak water surface height on these photos would be good if possible (if water surface is above the top of the photo, that could be noted in the caption).

- Use of “first period”, “second period”, etc is slightly ambiguous, instead I suggest listing the actual date ranges. Also is there not a close up photo for the second row?

Figure 4

- I had a hard time mapping photos E and F to their location in the channel on Figure C7

1, are they on there? Maybe this could be made more clear.

- Do impact marks refer to impacts of grains eroding paint, or groves, scours, etc. on the actual bedrock surface from impacting sediment? Perhaps showing a close-up of these impact marks would be helpful.

Figure 5

- I would change “assumed conditions” to “interpretation of conditions”

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Interactive comment on Earth Surf. Dynam. Discuss., doi:10.5194/esurf-2016-27, 2016.