

Earth Surf. Dynam. Discuss., referee comment RC1
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Comment on esurf-2021-3

Sarah Boulton (Referee)

Referee comment on "Bedrock River Erosion through Dipping Layered Rocks: Quantifying Erodibility through Kinematic Wave Speed" by Nate A. Mitchell and Brian J. Yanites, Earth Surf. Dynam. Discuss., <https://doi.org/10.5194/esurf-2021-3-RC1>, 2021

This paper sets out to test, using computer modelling, two recent theories (proposed by Perne et al. (2017) and Darling et al. (2020)) for the development of river profiles and rates of bedrock erosion with strong contrasts in bedrock strength with either horizontal or slightly dipping lithological contrasts. This broad research area has also been the focus of a number of other modelling and field-based investigations and the influence of lithology has often been an overlooked aspect of river evolution. As such this is a timely investigation into the role of bedrock strength that will be of use for the fluvial geomorphic community. However, there are issues that need addressing to improve the paper prior to final publication. I hope that these comments are useful to you in this regard.

Clarity and readability.

Unfortunately, I find that the paper is rather long and quite wordy and in places repetitive, so much so that often the key points that the you are trying to are lost on me. My main recommendation would be for you to cut the length of the methods and results sections to make these parts shorter and clearer. The methods section is 11 pages long. Could some of this information go in the supplements for the interested reader but for non-modellers only the key parameters and assumptions are described?

In addition, in the results section figures are often described in the text using virtually the same words as the accompanying figure captions but the key data, trend or observation that the reader should take away from these plots is not clear. This occurs for example on lines 552- 560, lines 682 – 686; line 704 – 709 etc. This means that often I am confused as to the key point being made and I would prefer the result to be stated not a figure description (e.g., What is high/low r^2 values? Lines 674/675; what the different spatial patterns? line 600)

Rock strength

There have been a number of recent papers based on field measurements of rock strength to determine K (i.e., Kent et al., 2020; Zondervan et al., 2020a; b in addition to those studies that you already cite) but you don't refer to these when discussing how you chose the K values for the strong and weak rocks. This is important as several of these studies indicate the in the real world erodibilities are many orders of magnitude less than values

used in models including these used on here. Given that the stated erodibilities are also stated to 3 significant figures – how did you come to these numbers and what are the implications for your models if all the rocks are 'weak' in comparison to the limited field data available?

Tank Wash

I would like to see greater justification for the use of the Tank Wash site as your 'field' area. It appears that there is no published geological map or other field constraints for the area – so is this really the best location? Although you recognise that this is 'far from ideal' there must be reasons you chose this site over somewhere else nearby on the map? But I'm not clear as to what these are? You do mention the stepped river profile but surely there are other similar locations that have better constrained bedrock data?

Additionally, what is the justification of using K values across such a large range? Is this using Stock and Montgomery (1999)?

On line 845 you state that dating of terraces is used to constrain uplift, but incision recorded by terraces often does not equal uplift owing to the processes of aggradation as well as incision that occur during terrace formation. Do you have any other constraints on uplift? What is the error on this parameter?

Minor comments

Line 56 – Reference needed for metrics of rock strength and channel steepness, maybe Zondervan et al. (2020b) or Bernard et al. (2019) would be suitable here.

Line 71 – is the word possible in this sentence appropriate – common would be my experience in most regions of the world.

Line 208 – what observations are you referring to here?

Lines 570 – 585 I'm not sure if this section is describing results or background information, maybe consider the location of this information.

Lines 434/437 - Why are dips expressed as negatives?

References not in pre-print

Bernard T, Sinclair HD, Gailleton B, Mudd SM, and Ford M., 2019. Lithological control on the post-orogenic topography and erosion history of the Pyrenees. *Earth Planet Science Letters*, v. 518, p. 53–66.

Kent, E., Whittaker, A.C., Boulton, S.J. and Alçiçek, M.C., 2020. Quantifying the competing influences of lithology and throw rate on bedrock river incision. *GSA Bulletin*.

Zondervan,, J.R., Whittaker, A.C., Bell,. R.E., Watkins, S.E., Brooke,. S.A.S. and Hann, M.G., 2020a. New constraints on bedrock erodibility and landscape response times upstream of an active fault, *Geomorphology*, v. 351, p. 106937-106937

Zondervan, J.R., Stokes, M., Boulton, S.J., Telfer, M.W. and Mather, A.E., 2020b. Rock strength and structural controls on fluvial erodibility: Implications for drainage divide

mobility in a collisional mountain belt. *Earth and Planetary Science Letters*, 538, p.116221.