Earth Surf. Dynam. Discuss., 3, C413–C415, 2015
www.earth-surf-dynam-discuss.net/3/C413/2015/

Earth Surface Dynamics Discussions

ESurfD

3, C413–C415, 2015

Interactive Comment

Interactive comment on "Experimental migration of knickpoints: influence of style of base-level fall and bed lithology" *by* J.-L. Grimaud et al.

J.-L. Grimaud et al.

jgrimaud@umn.edu

Received and published: 13 November 2015

We are grateful for the constructive and insightful comments of both referees. Comments by referee # 2 complement referee #1's suggestion to expand the discussion on the erosion process in play during the experiments. This is important because process understanding is a requirement both for predictive modeling and for comparing and scaling our results to natural observations. We will therefore add a paragraph in the manuscript with observations that may be pertinent for understanding erosion processes in the flume (i.e. synthetizing responses to referee #1 and #2).

Our approach focuses on the variation of bedrock strength on knickpoint dynamics. Lithological variations such as the effect of bedrock jointing or weathering (Miller, 1990) are not present in the experiments, potentially limiting the variability of erosion processes we can observe. For example we do not observe fracturing of joint planes along lithological variations because the substrate is homogeneous. Reduced friction along joints has been hypothesized as a prerequisite for, for example, erosion by plucking in waterfalls (review in Lamb et al., 2015) but was not present in our experiments.

One particularity of our experiments, pointed out by referee #2, is that all knickpoints are associated with a plunge pool. Hence, as mentioned in the paper, the erosion dynamics of the knickpoint face is probably related to its plunge pool dynamics. The turbidity observed within the plunge pool indeed suggests that most sediments are in suspension there, uncovering the bottom of the pool (Lamb et al., 2007) and perhaps providing abrasive tools for erosion. Assuming that abrasion increases with shear stress, we can compare the abrasion capacity along the flume using slopes. Shear stress is overall 0.9-1.9 Pa in the experiments (Table 1) and 2-5 Pa along the knickpoint faces (assuming flow depth is 1 mm), in accordance with erosion being maximal along the knickpoint face (i.e. higher than the 'background' erosion rate, see response to referee #1). A more accurate quantification of erosion through abrasion would require detailed tracking of sediment and flow dynamics than we were able to do. Our observations are limited by the size of the experiment but detailed study using advanced particle- and flow-tracking techniques such as laser holography (Toloui and Hong, 2015) in a larger facility would be a logical next step in this line of research.

Finally, undercutting and collapse of the knickpoint face is observed in the case of more resistant bedrock (2-5 % kaolinite), similarly to natural examples (Seidl et al., 1994; Lamb et al., 2007). In this case, we hypothesize that sediment-laden flows in the pool are able to erode backward compared to the overall flow sense due to vorticity in the pool and, potentially, the angle of incidence of the flow, which is set by the knickpoint slope. The conditions necessary for undercutting would be worth investigation in the future, for example combining physical experiments and high-resolution numerical simulations of flow and sediment transport.

All line edits suggested by the editor will be made in the manuscript, particularly the addition of curve fits in Fig. 7d. Finally we will further develop the discussion regarding the potential filtering of base level variation on scales smaller than the alluvium thickness (i.e. p. 783, lines 10-27).

Interactive comment on Earth Surf. Dynam. Discuss., 3, 773, 2015.

ESurfD

3, C413–C415, 2015

Interactive Comment