Earth Surf. Dynam. Discuss.,
https://doi.org/10.5194/esurf-2018-35-AC1, 2018

Interactive comment on "Clast imbrications in coarse-grained sediments suggest changes from upper to lower flow regime conditions" *by* Fritz Schlunegger and Philippos Garefalakis

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Received and published: 10 June 2018

We are very grateful for the comments by P. Carling as he addresses a point, which we admittedly have not considered with sufficient care. His thoughts thus allow us to broaden the discussion of our paper in an additional chapter, which we do with much appreciation as it allows us to improve the science of our work. Many thanks for this comment. In the original version of our paper, our explanations imply that the formation of an imbricated fabric of clasts is most likely associated with upper flow regime conditions. However, P. Carling notes in his comment that flume experiments did show ample evidence for clast imbrication to form when individual particles slide upon each other

(Carling et al., 1992). In addition, based on field observations, Sengupta (1966) reported examples where imbrications were initiated by the development of current crescents around pebbles that were embedded in sand, and that these processes possibly occurred during subcritical flows. Also during experiments, Johansson (1963) reported particle vibration before entrainment either through rolling or sliding. This author additionally noted that imbrication was formed by flow strengths, which corresponded to the lower flow regime during the flume experiments. Similar results were reproduced by Carling et al. (1992) in following-up experiments. These authors additionally showed that the shape of a clast has a strong control on the thresholds for incipient motion, the style of motion, and the degree of imbrication. The comment by P. Carling gives us the opportunity to include the overall conclusions and observations of these authors in our revised manuscript. We do admit that the possible controls of the shape of a clast on the degree of imbrication warrant a careful and detailed investigation (Hattingh and Illenberger, 1995). Unfortunately, we lack the quantitative dataset (which includes measurements of the a-, b- and c-axis of numerous clasts) to properly address this point, which we acknowledge in our revised manuscript. However, the way of how the experiments by Johansson (1963) and Carling et al. (1992) were set up imply that the imbrications most likely had shallow dips, similar to the fabric we have encountered on gravel bars in the Sense River (Figure 4C of our manuscript). Furthermore, the flume experiments also showed that the clasts were slightly displaced through sliding or vibrating before they started to pivot (Carling et al., 1992). These observations could be interpreted in the sense that incipient vibrating and sliding shifted the clasts to a more favorable position for pivoting (Carling et al., 1992). This suggests that pivoting most likely does require larger flow thresholds than sliding or vibrating, consistent with our interpretation of the Li and Komar's (1986) experimental results. While all three mechanisms (vibrating, sliding, pivoting) did occur during lower flow regime flows in these experiments at ideal and likewise controlled conditions, our natural examples paired with the simple modeling results do suggest that the formation of steeply dipping imbrications are more likely to form during upper regime flows. Further flume experiments (e.g., Hattingh and Illenberger, 1995) and field observations with a particular focus on the differentiation between flat and steep imbrication and the shape of the clasts might solve some of these open questions. We add an additional discussion section to outline these points. We do acknowledge, however, that we are not capable to fully address these issues with the information that is available to us. Nevertheless, we close our discussion with the diagnosis that while shallow imbrications could form during lower regime flows, the formation of steeply dipping imbrications more likely requires the occurrence of supercritical flows. Other points by Carling address the simplified way of how we consider the hydrological conditions, a point which we fully acknowledge. We also checked our formula and have not found any evidence for a circular reasoning. We change the title as suggested to better comply with the contents of our paper.

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