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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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I thank the authors for their considered response to the points I made in my previous comment, and their indication to modify the manuscript accordingly. From the Discussion the authors believe that steeply dipping imbrication on their examples of modern bars is related to migration of standing waves across the bar tops. Standing waves do indeed migrate which might resolve the issue of the spatial extent of imbrication and the occurrence of standing waves raised by Rebecca Hodge. It is a pity that the authors have no grain shape data or measurements of the angles of imbrication. Many publications mention (in passing) that steeper imbrication might be associated with faster flow although, to my knowledge, it has not been suggested prior that such steep imbrication is associated with the transition from upper-stage flow conditions to lower-stage flow conditions. From my experience I consider the occurrence of very steep imbrication angles for large numbers of grouped particles at a given location an indication of probable high-velocity flows, but draw no inference as to the flow-stage. I have observed imbrication angles of up to 70 to 90 degrees for tabular blocks, but ellipsoidal clasts rarely assume such steep angles. The transition from upper-stage flow to lower-stage flow can be associated with an hydraulic jump in which flow is very turbulent and this turbulence may entrain clasts (including into suspension) allowing them to be readily re-orientated upon deposition in lower-stage flows. In the Discussion, the authors believe that their identification of imbrication on modern bars is indicative of this transition. Note however that, as the authors state, the clasts are actually deposited within sub-critical flow although entrained within super-critical flow or within the transition.

In my original comment, I noted a possible ‘circularity of argument’ with respect to the application of the equations which, upon consideration, the authors cannot identify to be the case. Perhaps the choice of the word ‘circularity’ was imprecise on my part. In retrospect I should have been more specific. Within Equation 1, the density of water and sediment as well as the acceleration due to gravity for any one location are usually assumed constant. Then, if the Shields parameter is set to 0.47 (or any other value) for a given clast size, then the product of slope (S) and depth (d) is determined. If it is assumed that the clasts are at threshold of motion then the product Sd defines the hydraulic character of the flow for that critical bed state. Entering d into Equations 9 and 10 will dictate if the flow is super-critical or sub-critical. Accordingly the results hinge on the selection of the Shields parameter value and the value of S. Note that Equation 4 pertains to steady uniform flow and that the bed slope selected from the field studies is taken from topographic maps over a distance of 500m above varying-shaped bar forms and channel forms. It is evident that in such an environment, and for subcritical flow, the energy slope will not equal exactly the water surface slope nor the bed slope. Such inequalities increase substantially when unsteady non-uniform super-critical flows and transitions are considered to which Equations 4 and 5 cannot be applied with confidence. The authors acknowledge that if a Shields value of 0.03 is selected, many of the considered flows remain sub-critical, and such may also be the case if energy slope values are used that are less than the bed slope values. Note that the energy slope term will always decrease more rapidly across a transition in contrast to the bed slopes rate of adjustment. Consequently, the results of any critical Froude analysis are very sensitive to the choice of values of S, as well as the critical Shields parameter. Stating the above does not imply that steep imbrication cannot occur in super-critical flows but that, in this particular case study, formation in sub-critical flow cannot be ruled-out.

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