Response to Anonymous Referee #2 Interactive comment on "Image analysis for measuring stratigraphy in sand-gravel laboratory experiments" by C. Orrú et al.

The authors are thankful to anonymous Referee#2 for the helpful review and constructive comments. In the following we respond to the proposed revisions and comments.

1. The proposed reference (Marion and Fraccarollo, 1997) about the freezing technique will be included in the introduction.
2. Further description and references regarding Gilbert deltas will be added to the manuscript in the introduction.

   In the following we show a new version for Figure 1.

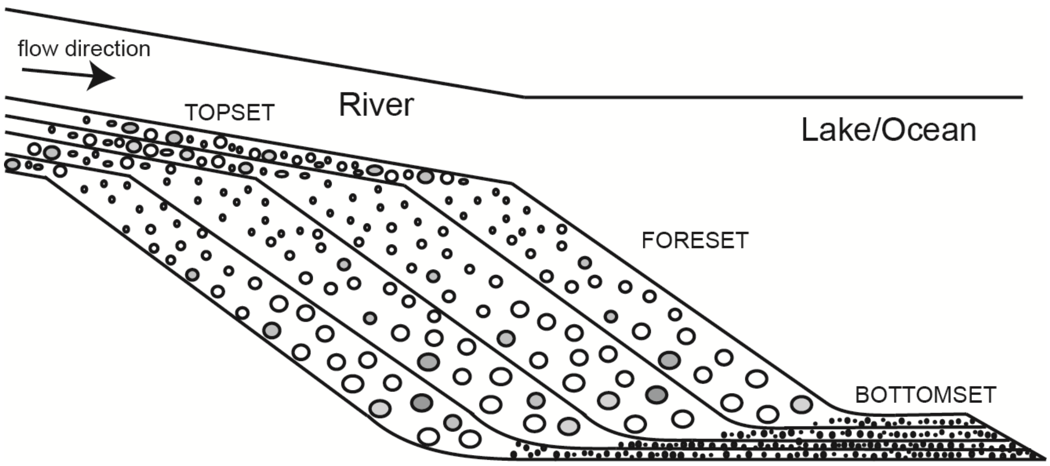


Figure 1 Schematic of a Gilbert-type delta (after Gilbert, 1890).

Experiment E1 and experiment E2 were conducted with the same initial and boundary conditions. The only slight difference among the two is the geometry of the resulting deltas. The length of the delta in Experiment E1 was about 1.4 m and in Experiment E2 was about 1.2 m. As mentioned in the manuscript the height of the delta deposit was about 18 cm in Experiment E1 and the height of the delta deposit in Experiment E2 was about 16 cm.

3. The Lab colour space is like the RGB colour space, composed of three dimensions. In the case of RGB the dimensions are given by Red, Green and Blue values. A colour results from the combination of the percentages of Red, Green, and Blue values. The Lab colour space combines the luminosity dimension L and the colour (so chromatic) dimensions a and b. Here, the colour information is in the a and b dimensions. The parameter a indicates how the colour plots along the red-green axis, and b indicates how it plots along the blue-yellow axis.

   Colour segmentation indicates the division of all the pixels present in an image into a limited number of imposed colour groups (i.e. clusters).

   K-means clustering (MacQueen, 1967) is a partitioning method aimed at dividing a set of objects into groups (i.e. clusters) based on their attributes. Each object has a location in space. The distance from this location to a representative point of the cluster (i.e. cluster centre) is used to define to which group the object belongs. Using an iterative algorithm the objects are moved between the clusters until the sum of distances from each object to its cluster centroid is minimized. Although the method can be applied to a very wide range of cases, we use it to divide a set of pixels into colour groups to determine an average value for each colour (i.e. cluster centre).

   The above explanations will be added to Section 2.3 "Image analysis" in the manuscript, before explaining the image analysis procedure.

4. Equation 1 was derived to convert each point of the areal grain size distribution, resulting from the image analysis measurement, to the measured volumetric distribution provided by the sieve analysis. The k parameter is an empirical value based on our experimental data. Its value was found by striving for the minimum mean absolute difference between the measured and predicted volume fraction contents of two (i.e. fine and medium) out of three size fractions for 64 sediment samples.

   Based on the comments by Referee#2, we have compared the results of our conversion model to the ones of the conversion model proposed by Parker (1991a,b). The latter originates from the conversion model developed by Proffitt (1980) and Diplas and Sutherland (1988) and provides an estimate of the areal fraction content based on a given volume fraction content. The model by Parker (1991a,b) rewritten in the form as presented by Cui and Parker (1998b, 2005) is:

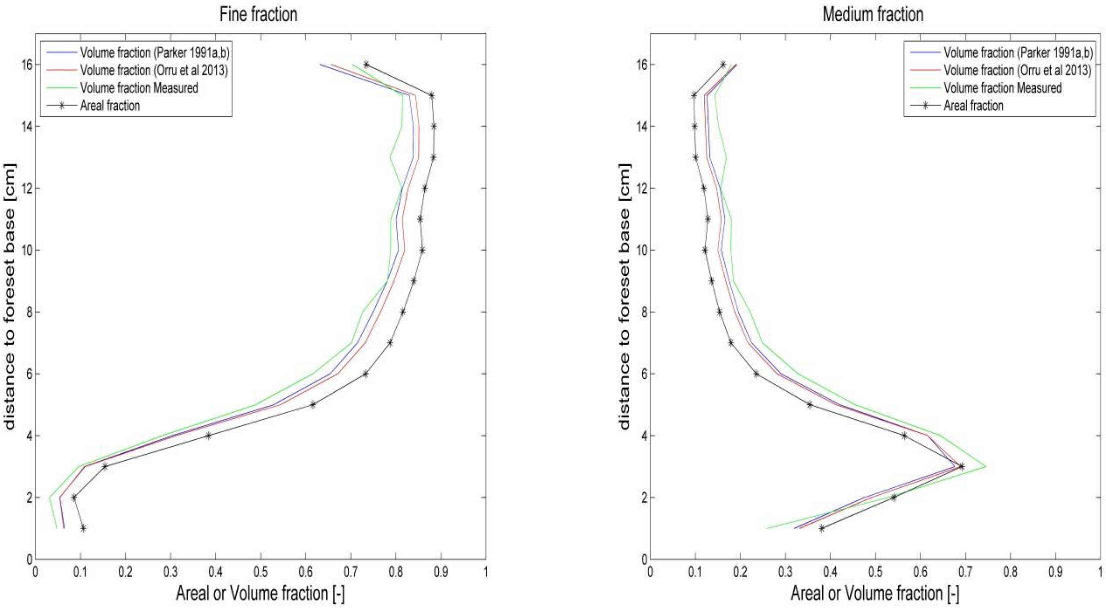
$$F_{Ai} = \frac{F_{Vi}/\sqrt{D_i}}{\sum_{k=1}^{N}(F_{Vk}/\sqrt{D_k})} \quad (1)$$

where F_{Vi} denotes the volume fraction content of size fraction *i* in a sediment layer [-], F_{Ai} is the areal fraction content of size fraction *i* in the same sediment layer [-], D_i is the grain size of size fraction *i* [m].

The Parker (1991a,b) conversion model was used, as requested by Referee#2, starting from the areal fraction content, F_{Ai}, resulting from our image analysis, to compute the volume fraction content F_{Vi}. In the reverse form Equation (1) is written as:

$$F_{Vi} = \frac{F_{Ai}\sqrt{D_i}}{\sum_{k=1}^{N}(F_{Ak}\sqrt{D_k})} \quad (2)$$

The model proposed by Parker (1991a,b) results in a volumetric distribution that is very similar to the one obtained using our model. Figure 2 shows the comparison between the measured areal and volumetric fraction contents, as well the computed volumetric fractions using the Orrú et al. (2013) model and the Parker (1991a,b) model.



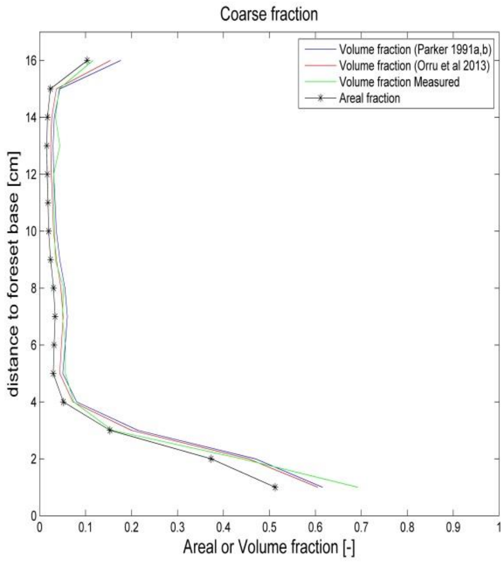


Figure 2 Comparison of the predicted volume fractions by the Orrú et al. (2013) and the Parker (1991a,b) models and the measured volume and areal fractions for Experiment 2, Side sample.

Since the difference between the outcome of the Orrú et al. (2013) and Parker (1991a,b) models is very small and the Parker model even shows slightly better results, we will only apply the Parker (1991a,b) conversion model in the manuscript. The text between line 6 page 994 and line 3 page 996, and Figure 15, 16 and 17 will be modified explaining the application of the Parker (1991a,b) conversion model. The new results, here shown in Figure 2, will be included and discussed.

5. Comparing the data from the central and side area we observed differences in the grain size distribution. A coarser mixture is found at the sides, which is due to side wall effects that caused a slightly parabolic front of the delta. Up to a distance of about 0.03 m from each flume wall more coarse sediment was deposited at all elevations. For the same reason, to create Figure 18 we have removed the data corresponding to 0.03 m from each sidewall of the flume. The size stratification of the delta corresponds therefore to an area equal to 0.34 m x 0.06 m (lateral vs. streamwise distance) instead of 0.40 m x 0.06 m (see manuscript at page 996, line 7). An example of a side view picture can be seen in the manuscript in Figure 3. It is observable that on the side walls of the flume primarily the coarse sediment (yellow and red grains) is deposited, which does not represent the main part of the deposit.

6. We thank the reviewer for pointing out the incorrect use of the term “errors”. We agree with this comment and we will rephrase the sentence at page 992.
7. We experienced that the sampling with the vacuum cleaner is not size-selective and does not show a preference for the fine fractions. The fact that the sediment is painted helped us to verify the removal of all size fractions. For instance, the coarser yellow particles are clearly distinguishable and it is visible when they are removed by the vacuum cleaner together with the finer fractions. Moreover, the vacuum cleaner is used passing over the same area several times until the 1 cm thick layer is removed. This helps us to collect all fractions from that layer. Additionally, our results do not suggest that the vacuum cleaner prefers entrainment of the finer fractions. Please note that the finer fractions are underestimated in the volume fraction contents derived by the sieve analysis of the sampled layers. If the vacuum cleaner would have shown preference to entrain the finer fractions, we would have found the opposite result.

References

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