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# Comparison of Spatio-Temporal Evolution of Experimental Particulate Gravity Flows at Two Different Initial Concentrations, based on Velocity, Grain Size and Density Data

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## 1. Introduction

Subaqueous particulate gravity flows experiments with 14% initial concentration were undertaken to gain insights into the spatio-temporal development of flow structure in terms of horizontal velocity, root mean square (RMS) velocity, concentration and grain size, and to make a comparison with the evolution of flows of 5% initial concentration, described by McCaffrey et al. [1]. At this higher initial concentration (14%), particle-particle interactions are expected to influence flow behaviour, via moderate turbulence suppression.

## 2. Experimental set-up

The sediment analogue was polydispersed silica flour (mean particle size $\sim$ 8 microns). A uniform 30 litres suspension was prepared in an overhead reservoir, then allowed to drain into a flume 10m long and 0.3 m wide, water-filled to a depth of 0.3m. Each flow was siphoned continuously for 50 s at 5 different heights (spaced evenly from 6mm to 46mm) with samples collected at a frequency of 0.25 Hz, generating grain size and concentration data. Simultaneously, six 4-MHz UDVP (Ultrasonic Doppler Velocity Profiling) probes recorded the horizontal component of flow velocity. All but the highest probes were positioned at the same height as the siphons. The sampling location was shifted 1.32m down-current for each of the 5 nominally identical flows, yielding sample locations at 1.32m, 2.64, 3.96 5.28 and 6.60 m from the

inlet. Time series of downstream flow velocity and its calculated degree of turbulence, median grain size and sediment concentration at different positions along the path of nominally identical flows are analysed and combined to constrain the spatio-temporal evolution of a single idealised flow.

### 3. Results & Conclusions

Comparison of the 14% flow with a flow of 5% initial concentration reveals similarities in the basic spatio-temporal structure of velocity, turbulence, grain size and concentration. Both flow types exhibit a velocity maximum at about 1/3 above the flume floor. At that level, velocity decreases slowly in the flows' body and more rapidly in their tails. Moreover, turbulence intensity is highest in the head and at the base of the flows, whereas the level of maximum velocity and the tail of the flows typically are weakly turbulent. The zones of high turbulence are associated with coherent flow structures generated by shear at the front and base of the gravity flows. The 5% and 14% flows also agree in stratification patterns of median grain size and concentration. Grain populations are relatively well mixed in the head, show normal grading in the main part of the body and normal to inverse grading in the rear of the body and tail. The inverse grading is thought to originate from particles transported from the head upward and backward into the body of the flows, where they subsequently settle. The main difference between the 5% and 14% flows is that the 14% flows appear to develop from a jet into a turbidity current closer to the inception point than the 5% flow. This difference is interpreted from dimensionless vertical profiles of the flow parameters: horizontal velocity, concentration and grain-size distribution (and their derivatives). In the turbidity current phase of both flows, the dimensionless variables collapse well. This indicates that the flows behave in a dynamically similar manner and inspires confidence that the dimensionless variables could be used to predict the dynamic behaviour of particulate gravity flows across the measured concentration range in the flume, which due to dilution effects, was from $\sim$7 to $<$ 1 vol % initial concentration.

**Reference:** [1] McCaffrey W.D., Choux, C.M.A., Baas, J.H., and Haughton, P.D.W. (2003), Spatio-temporal evolution of velocity structure, concentration and grain size stratification within experimental particulate gravity currents: *Marine and Petroleum Geology*, 20, 851-860.