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Turbulent behaviour of non-cohesive sediment gravity flows at unexpectedly high flow density

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Experimental lock exchange-type turbidity currents laden with non-cohesive silica-flour were found to be highly dynamic at remarkably high suspended sediment concentrations. These experiments were conducted to produce sediment gravity flows of volumetric concentrations ranging from 1% to 52%, to study how changes in suspended sediment concentration affects the head velocities and run-out distances of these flows, in natural seawater.

Increasing the volumetric concentration of suspended silica-flour, C, up to C = 46%, within the flows led to a progressive increase in the maximum head velocity. This relationship suggests that suspended sediment concentration intensifies the density difference between the turbulent suspension and the ambient water, which drives the flow, even if almost half of the available space is occupied by sediment particles. However, from C = 46% to C = 52% a rapid reduction in the maximum head velocity was measured. It is inferred that at C = 46%, friction from grain-to-grain interactions begins to attenuate turbulence within the flows. At $C > 46\%$, the frictional stresses become progressively more dominant over the turbulent forces and excess density, thus producing lower maximum head velocities. This grain interaction process started to rapidly reduce the run-out distance of the silica-flour flows at equally high concentrations of $C \geq 47\%$. All flows with $C < 47\%$ reflected off the end of the 5-m long tank, but the head velocities gradually reduced along the tank.

Bagnold (1954, 1963) estimated that, for sand flows, grain-to-grain interactions start to become important in modulating turbulence at $C > 9\%$. Yet, the critical flow concentration at which turbulence modulation commenced for these silica-flour laden flows appeared to be much higher. We suggest that Bagnold's 9% criterion cannot be applied to flows that carry fine-grained sediment, because turbulent forces are more important than dispersive forces, and frictional forces start to affect the flows only at concentrations just below the cubic packing density of spheres of C = 52%. These experimental results also imply that natural flows may be able to transport vast volumes of non-cohesive sediment with relative ease, especially considering that the experimental flows moved on a horizontal slope.

References

Bagnold, R. A. (1954). Experiments on a Gravity-Free Dispersion of Large Solid Spheres in Newtonian Fluid under Shear. *Proceedings of the Royal Society series A: Mathematical, Physical and Engineering Sciences*, 225(1160), 49–63.

Bagnold, R. A. (1963). Beach and nearshore processes: Part 1. Mechanics of marine sedimentation. In: Hill, M. N. (Ed.) *The Earth Beneath the Sea, vol. 3.* Wiley-Interscience, London, 507–533.