The Role of Grain Size on Flow Structure and Concentration Profiles in Sediment Gravity Currents

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Increasingly, turbidity currents have become the focus of intense laboratory investigation, and which, during the past several years, have yielded great insight into the processes governing flow structure and sediment stratification over the length and depth of the current. However, capturing simultaneous velocity and concentration data in sediment gravity currents has proven difficult due to the technological limitations of traditional sampling instruments. As such, previous studies relating to flow structure have relied largely on saline solutions to produce the density difference, and it is uncertain how representative these conditions are of sediment transporting gravity currents. Similarly, past work using sediment mixtures have been unable to fully capture flow characteristics, especially in terms of coherent turbulent flow structures. Therefore, a complete picture governing the complex feedback mechanism between flow structure, sediment transport and bedform development in turbidity currents remains elusive. Moreover, little is known about how these processes are affected by varying grain size and sediment concentration.

This study attempts to address how grain size affects flow structure and concentration profiles in sediment gravity currents. Simultaneous three-dimensional velocity and concentration profiles were collected through the entire length of the current using a three-dimensional ultrasonic Doppler velocity profiler (3D-UDVP) and a computed tomography (CT) scanner, respectively. Two experimental runs are presented using grain sizes of 0.105 mm and 0.150 mm with initial concentrations of 5% by mass. Preliminary results show that the velocity and concentration profiles are generally consistent with those reported from previous studies using saline and sediment transporting gravity currents. However, in these new runs the spatial and temporal evolution of the body and tail parts of the flow differ between the two runs, and appear to be related to the higher settling velocity in the coarser sediment run. Such differences in flow field properties may help explain some of the diversity in bed sequence characteristics observed in natural turbidity current deposits.