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Looking inside a debris flow

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Debris flows, masses of saturated, channelized, granular materials that flow at high speeds downslope, present a hazard to lives and infrastructure in regions of high relief and runoff. They also present a challenge to modelling due to the heterogeneous, multi-phase, nature of the constituent materials, with particles ranging from boulder-size to silt-size and fluid viscosity being altered by the presence of fine particles and clay. As a debris flow travels on its flow path, it will tend to segregate, with larger particles being focused to the flow front and fluid being concentrated in the tail – resulting in different rheological behaviour in time and space. It will also tend to erode and deposit material as it moves through different channel segments or reaches, with this behaviour influenced by the confinement of the channel and the angle of the slope within each reach.

Flume studies offer the potential to examine in detail the behaviour of model debris flows within the penultimate and final (deposit fan area) reaches – zones which are generally of most interest in terms of human risk. Flume studies which are conducted using transparent debris offer additional benefits to more traditional methods that use opaque materials, enabling insights to the flow behaviour that are inaccessible via other physical methods.

We present flume model work which has been designed to capture some essential aspects of debris flow behaviour using well graded (polydisperse) transparent debris, albeit at reduced scale. These aspects include the final deposit spread or runout increasing for a lower concentration of solids and a higher penultimate reach slope angle, and observable particle size segregation during downslope motion. We present time-varying measurements made internally and externally at a point in the channel via Plane Laser Induced Fluorescence and Particle Image Velocimetry, PIV. The measurements enable velocity distributions of the segregating flows over time to be determined that can be directly compared with theoretical relationships developed from measurements made at flow margins.