Title: Exploring pyroclastic density currents with analogue models

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Main text:

Pyroclastic Density Currents (PDCs) are a volcanic hazard associated with explosive volcanic eruptions. A PDC can form when a volcanic eruption cloud collapses on itself, when unstable lava domes crumble, or from lateral blasts. This creates a rapidly moving (100s m/s), high temperature (up to 1,000°C) mixture of heterogeneous volcanic material and gas that can flow tens to hundreds of kilometres down the flank of a volcano with little warning. Fluidisation within PDCs plays a substantial role in their high mobility and is thought to be an outcome of excess pore pressure from exsolution and entrainment. However, the complex fluid dynamics of these systems are not well-known because it is impossible to directly measure natural PDCs. Understanding the behaviour of these currents is essential for hazard prediction and assessment.

Small-scale analogue modelling of PDCs allows the fluid dynamic parameters to be explored within a controlled and accessible environment. As fluidization processes do not operate at the laboratory scale, they are often overlooked in flume experiments. However, their effect can be mimicked by injecting gas through a porous base in the flume. In these experiments, material (such as glass ballotini) is released into the flume and the current becomes aerated on contact with the base. Control of aeration throughout individual chambers of the flume can isolate fluidization velocities and initiate deposition of the current. Current dynamics and sedimentation behaviours can be quantified through particle tracking, post-video analysis and deposit excavation.

This method has initiated exciting research into the relationship between flow variables (such as grain size and density), the resulting current behaviours (for example, velocity structures), and the growth of deposited material. Quantifying the link between process (the current) and product (deposits) allows for improved interpretation of volcanic sequences and therefore hazard assessment. Future work will quantify current behaviour in more complicated settings, such as in the presence of water and around topography, the interaction with the substrate and how these affect erosional and depositional behaviours.

Image Credit: Dr Pete Rowley, University of Bristol

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