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Forming dune-like bedforms in dense pyroclastic density current analogues

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Pyroclastic Density Currents (PDCs) are hot, density driven mixtures of gas and volcanic particles formed during explosive volcanic eruptions. They are capable of depositing large ignimbrite sheets, which can exhibit a variety of sedimentary structures. PDCs are known to have high gas pore pressures, causing fluidisation, which is thought to explain their greater than expected runout distances. The occurrence within PDC deposits of dune bedforms is taken as indicative of dilute, turbulent flow causing traction-dominated deposition.

Here, we further examine the effects of heterogeneous aeration on the depositional behaviour of dense analogue currents. In these experiments we use a novel flume apparatus that not only allows the simulation of high pore pressure by aerating the current through a basal gas flux, but which can provide different fluxes to three different divisions of the flume channel. This allows the modelling of different degrees of aeration within the same current, which is significant as PDCs are intrinsically heterogeneous in time and space.

Previous experimental work in flumes has shown how sustained, aerated currents aggrade deposits thicker than the current itself, have much longer runout distances than non aerated currents, and that de-aeration triggers deposition. We show how dense granular currents can form a variety of progressive, planar, and regressive dune bedforms; controlled primarily by the current velocity. These dune bedforms are the product of a dense granular flow, and form without any interference from an overlying turbulent layer. As the presence of dune bedforms is commonly used as diagnostic evidence for dilute, turbulent currents, this has important implications for field interpretation, implying that dune bedforms in natural PDC deposits may have formed under a range of conditions.