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The physical properties and rheological characteristics of flowing volcanic ash: first insights from laboratory rheometric analyses

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The mobility of geophysical granular flows (e.g. pyroclastic density currents, debris avalanches, etc.) is controlled by the energy involved, the physical properties of the flowing material and the interaction of the flowing material with the local topography. Physical properties of granular material like grainsize, density, polidispersity and particles shape in turn influence how the granular material deforms and eventually flows in response to an applied stress. The latter is captured by parameters like the angle of internal friction, the wall friction angle, flowability, etc. One way in which variations in physical properties is manifest is in the flow-averaged mobility variations between different types of pyroclastic density current. These properties are also important because they comprise some of the input parameters required for numerical simulations and specifically computational fluid dynamics simulations of the flowing mixtures.

In the framework of a recently funded NERC Standard Grant (NE/R011001/1, Granular flow rheology; the key to understanding the exceptional mobility of pyroclastic density currents, University of Edinburgh, British Geological Survey, Heriot Watt University) we have conducted systematic powder rheometry laboratory measurements of granular material sampled from real pyroclastic density currents deposits (PDC). By means of the compressibility, shear and wall friction tests performed using the FT4 powder rheometer (Freeman Technology), material bulk density, angle of internal friction (yield curve), wall friction angle and the flowability of the natural samples have been determined. These parameters have been evaluated for both bulk samples of PDC matrix material as well as specific grainsize sub-fractions. Preliminary results show that these parameters are strongly controlled by the material properties, in particular the grainsize distribution and the variable contents of fine ash.

We aim to create a database of rheometric properties that can be used for modelling applications, both for PDCs as well as debris flows.