Application of classical laboratory rheometric analyses for the study of the influence of volcanic ash physical properties on their flow behaviour.

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Abstract

Over the last two decades, the study of granular material flow has considerably improved due to the implication in various industrial (granulation, coal gasification, etc.) and natural applications (avalanches, volcanos eruptions, etc.). In geophysical science, the study geophysical granular flows such as pyroclastic density currents, debris and avalanches is of great interest. Indeed, one of the major challenges is to understand how the energy involved, the physical properties and the interaction of the flowing material with the local topography affect the mobility of the granules. The physical properties of granular material like such as grain size and density, polidispersity and particles shape are known to play a major role in how the material deforms and eventually flows in response to an applied stress. The main objective of our work is to use classical laboratory rheometric analyses (shear tests, wall friction tests, etc.) to improve the understanding of the impact of volcanic ash physical proprieties on their flow behaviour, which to our knowledge is not well documented in the literature.
To pursue the objectives of the work, we employ the automated FT4 powder rheometer developed by Freeman Technology Ltd. (Castlemorton Common, Worcestershire, UK). The shear tests were performed with different initial consolidation stress on different ash samples of different size in order to evaluate physical parameters, such as the angle of internal friction and the flow function coefficient FF to provide information on the flow behaviour of the studied powder. The FT4 compressibility test was also used in order to evaluate how the density of the studied powder changes as a function of the applied normal stress. The wall friction angle of the studied powder, at different wall roughnesess, was evaluated using the wall friction test of the FT4.

In the framework of a collaboration with the British Geological Survey and the University of Edinburgh we have conducted preliminary tests on two volcanic ash samples (pyroclastic and debris flows) from the same volcano eruption in Alaska. The grainsize distribution analysis of both samples showed a highly polydispered powder with a high percentage of very fine ash (lower than 45 mm). Both samples were tested as bulk material as well as specific grainsize sub-fractions. The angle of internal friction was found to be the same for both samples and it was show to be independent of the initial consolidation stresses and

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the grainsize fractions. According to Jenike [1] classification, the first results showed that the flowability of the studied powder is strongly affected by it grainsize distribution and the initial consolidation stress. This result was confirmed by the compressibility test results. For a fixed grainsize distribution and wall roughness, the wall friction angle appeared to be the same for both samples. However, the results showed that the wall friction angle is affected by both the grainsize distribution and the roughness of the wall.

The results obtained in this work are the first of their kind in the geophysical science and we aim to create a database of rheometric properties for a variety of ashes from different origin and for Pyroclastic and debris flows.

A.W. Jenike, Storage and flow of solids, Rev. ed, Salt Lake City, Utah: University of Utah, 1970. https://trove.nla.gov.au/version/31369081 (accessed March 20, 2018).

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