Which models for granular flows in volcanology?

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Pyroclastic flows are mixtures of gases and particles (fragments of solidified lava) caused by the collapse of a lava dome or eruptive column. These are extremely destructive phenomena that are known to propagate over long distances, even over almost flat terrain.

For several years now, in collaboration with geologists from the Laboratoire Magmas et Volcans (Clermont-Ferrand), we have been working on models to better understand these flows.

There are still many unresolved issues, and the problems are diverse :
- Why do these granular flows seem so fluid ?
- What is the rheology of this type of material ?
- What physics can account for expansion phenomena ?
- Are the underlying mathematical models well posed ?
- What numerical methods could be adapted to this kind of problem ?

The work presented here corresponds mainly to that recently published in [1]. In this paper, a PDE model is proposed for mixtures of solid particles, at high volume concentration, and a gas.

The aim is to obtain a model with as many positive points as possible with respect to the aforementioned problems. We shall see that it is possible to obtain well-posed models (in terms of stability), which make physical sense both in terms of taking into account the fluidisation of these flows, expansion and the choice of rheology (around the law classically known as $\mu(I)$).

Finally, I will discuss the natural prospects for these models, namely the implementation of a well-adapted scheme and the realisation of a technical point of view.

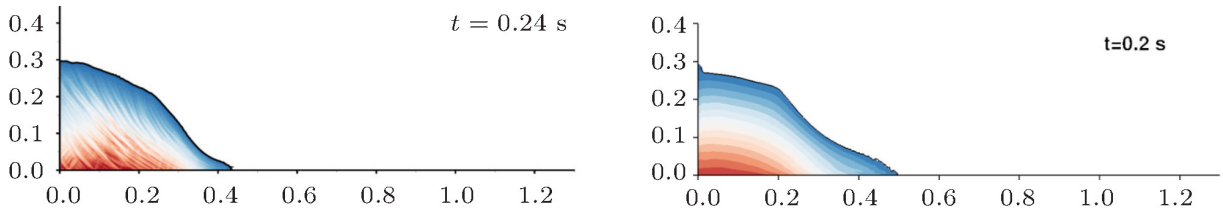

FIGURE 1 – These two simulations correspond to pressures measured in the collapse of a granular column. On the left, the model does not take fluidisation into account and instabilities are observed, whereas on the right, taking fluidisation into account limits these instabilities.

[1] L. Chupin, T. Dubois. *Non-isochoric stable granular models taking into account fluidisation by pore gas pressure.* Journal of Fluid Mechanics, **979**, A14, 2024. doi :10.1017/jfm.2023.1010.

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