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Challenges modeling clastic eruptions: applications to the Lusi mud eruption, East Java, Indonesia.

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Clastic eruptions involve brecciation and transport of the hosting rocks by ascent fluids (gas and/or liquids), resulting in a mixture of rock clasts and fluids (i.e. mud breccia). This kind of eruptions is often associated with geological features such as mud volcanoes, hydrothermal vents or more generically with piercement structures. Over the past decades, several numerical models, often based on those used in volcanology, have been employed to better understand the behavior of such clastics systems.

However, modeling multiphase flow is challenging, and therefore most of the models are considering only one phase flow. Many chemical, mechanical and physical aspects remain still poorly understood. In particular, the rheology of the fluid is one of the most important aspects, but also the most difficult to characterize. Experimental flow curves can be obtained on the finest fraction, but coarser particles (> 1mm) are usually neglected. While these experimental measurements usually work well on magma, they are much more difficult to perform when clay minerals are involved.

As an initial step, we use analytical and simplified numerical models (flow in a pipe) to better understand the flow dynamics within a main conduit connected to an overpressured reservoir. The 2D numerical model solves the stokes equations, discretized on a finite element mesh. The solid phase is treated as rigid particles in suspension in the liquid. The gaseous phase (methane and carbon dioxide) is treated in an analytical manner using the equations of state of the H_2O-CO_2 and H_2O-CH4 systems.

Here, we present an overview of the state-of-the-art in modeling clastic eruptions as well as the limitations and challenges of such numerical models. We also discuss the challenges associated to the specific case of Lusi. In particular the difficulty to characterize the mud properties and the technical challenges associated with the acquisition of new data and development of more sophisticated models. Previous attempts to model e.g. the longevity of the Lusi eruption were not particularly successful. A possibility is because the sedimentary hosted hydrothermal system is reactivated by frequent seismicity and by the connection with the neighboring volcanic complex feeding it.