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SHALAVA: a numerical program for simulation of effusive volcanic eruption

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In the context of hazard evaluation and risk mitigation, we present a numerical model for an effusive volcanic eruption which is able to quickly (in a few minutes of run time) predict the evolution in time and space of a lava flow. The model based on the conservation laws of mass, momentum and energy, and includes viscoplastic rheology which is the best behavior law to simulate lava flows. The model also takes into account the variation of temperature in the lava and the variation of viscosity and yield stress with the cooling.

The model works on a general topography (in practice a DEM), and takes into account the effect of forest (network of vertical obstacles). To produce a fast simulation and to predict beforehand the path of a lava flow, we use some approximations and numerical tools, including a shallow-depth approximation, a multilayer solution of heat equations and a Darcy law to model the effect of forest by an equivalent continuum medium. With these assumptions, the initial 3D initial problem is reduced to a 2D solution.

A graphic interface has been developed to allow users to run a simulation really quickly in an interactive fashion, and in real-time, during an on-going volcanic eruption. The software uses some elementary data such as rheological and thermal parameters for the lava, the DEM around the vent, the GPS coordinates of vent, the flow rate (constant or variable) and the characteristics of the forest (if there is one). In a few minutes, the program provides many hours of simulation. The model has been tested on several eruptions, including effusive events involving ingress into forested areas and barren zones at Kilauea and Piton de la Fournaise, as well as laboratory experiments, with good results.