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Introduction of more physical features in the Cellular Automata model for lava flows SCIARA: preliminary results regarding the viscosity.

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Several Cellular Automata (CA) models have recently been developed for simulating lava flows with satisfying results. Our research group developed several versions of SCIARA (Simulation by Cellular Interactive Automata of the Rheology of Aetnean lava flows), a two-dimensional CA model for the simulation of lava flows, and validated it on real cases of Etnean eruptions. SCIARA describes lava flows as a dynamic system, based on local interactions with discrete time and space, where space is represented by hexagonal cells, whose specification (state) describes the characteristics (substates) of the corresponding piece of space. The state changes according to a transition function that depends on the states of neighbouring cells and of the cell itself; the transition function is identical for all the cells. At the step 0, cells are in states, describing initial conditions, and the CA evolves changing the state of all the cells simultaneously. The substates of the basic version of SCIARA are: altitude, lava thickness, temperature, lava flows. The substate altitude introduces implicitly the third dimension in the simulation. The distribution of the lava is based on an algorithm of minimisation of the differences in height (altitude plus lava thickness) in the neighbourhood. The viscosity is treated in an empirical way: a lava extent (in height) is considered adhering to soil and being not movable. This quantity, called adherence, is depending on temperature according to a simple Arrhenian relation. Such an approximation becomes critical for low lava flows. We are investigating an improvement, introducing a simplified equation of velocity, deduced by the Navier Stokes equations, where the viscosity appears explicitly; its value is depending also on the temperature,

according to physical equations. The velocity is computed for each “minimised” lava flow between two cells together with the lava flow shift in the time corresponding to a SCIARA step. The ratio of the shift with the distance between the centers of the two cells, determines the quantity of entering lava outflow. The introduction of the viscosity in the SCIARA basic version produced interesting results in simulations of lava flows of recent Etnean eruptions. They show some improvements in comparison with the basic release. This is a first step in order to introduce opportunely such a variation in more sophisticated SCIARA releases.