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Modelling lava flows characterised by distinct temperatures: a first attempt through the “double layer” approximation

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Several Cellular-Automata models have recently been developed for simulating lava flows with quite satisfying results. Though, these models generally simplify (among other factors) the management of flow temperature - e.g. they do not consider the possibility of "amounts" of lava characterised by different temperatures in the same cell, and then permit the perfect “combination” of distinct lava flows (at different temperatures), except for the extreme case of solidified flow. This study presents a double-layer release of the CA-model SCIARA, in which flows characterised by two distinct temperatures are allowed in a given cell. This new release preserves the basic features of the model SCIARA (hex-1): i.e. hexagonal cells, substates “altitude”, “lava thickness”, “temperature”, “lava outflows”. Moreover, lava distribution among the cells is still ruled by the same minimisation algorithm, and lava cooling is governed by the radiation equation. With respect to previous releases of the model, changes concern the mixing of lava inflows, and of residual lava inside a given cell. These lava portions may show different temperatures, and in some cases they may constitute distinct “layers” (i.e. they do not completely mix) - a situation which is very difficult to be modelled. In the present release of the model, this case is managed in a simplified way: distinct amounts of lava are reduced to two layers (the upper layer and the lower layer), characterised by different temperatures. The hottest layer constitutes the upper layer, while the remaining material is mixed and unified to constituting the lower layer.

A threshold concerning temperature difference is imposed (CA-parameter), in order to permit the mixing of material whose difference in temperature does not overcome the threshold. Applications of the model to some recent cases of Etnean lava flows are discussed. With respect to simulations performed with previous versions of the same model, the present release demonstrated to be able to better manage some peculiarities of flow development which could not be ignored when temperature differences of distinct flow branches become significant.