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A 3-D dynamical model for channeled lava flow with non linear rheology

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Recent laboratory studies on the rheology of lava rock samples from different volcanic areas have highlighted that the apparent viscosity depends on a power of the strain rate. Several authors agree on attributing this dependence to the crystal content of the sample and to temperature. Starting from these results, in this work we studied the effect of a power-law rheology on a gravity driven lava flow. The equation of motion is non-linear in the diffusion term and analytical solution for the equation does not seem to be possible. The finite-volume method has been applied to solve numerically the equation governing the fully developed laminar flow of a power-law non-Newtonian fluid in an inclined rectangular duct. The convergence, the stability and the order of approximation were tested for the Newtonian rheology test case, comparing the numerical solution with the available analytical solution. The results indicate that, for a lava flow with constant volume flow rate, the use of a power-law rheology produces important differences in the thickness of lava flow and in the average velocity of the flow respect to the Newtonian case.