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Modeling of gravitational multi-phase lava flows with breccias

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A volcanic lava flow complicated by moving breccias is important in assessments of lava flow hazards. Considering this as the primary research goal, we develop three-dimensional numerical models of multiphase lava flow (each lava phase differs by its density and viscosity) due to gravity overlain by rigid breccias. A mathematical statement of the model problem presents the Stokes equations combined with the advection equations for density and viscosity of the fluid, approximating a lava, together with specified conditions at the model boundaries. The mathematical model is discretized and solved by the finite volume method. Introducing various spatial distributions of a fractured crust over the lava in the models, which approximate breccias, we analyze the dynamics of the lava flow with breccias over a horizontal plane including barriers as well as over a real surface topography. We show that the rate of lava flow changes depending on the prescribed conditions at the bottom surface of the models, and the rates are higher in the case of the frictional conditions (compared to no-slip conditions). We show also that the spatial distribution of floating breccias varies with time, with the boundary conditions, and with the size of the breccias.