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The Propagation of Viscous Gravity Currents over a Rigid Conic Surface

A.A. Osiptsov, A.A. Barmin, O.E. Melnik

Institute of Mechanics, Lomonosov Moscow State University, Moscow, Russia

Asymptotic models of a thin-film flow of highly viscous heavy fluid with mass supply on a curved rigid surface with small and finite inclination angles of the surface generatrix to the horizontal are constructed. The existence of a steady-state solution for the free-surface shape (absent in the case of a horizontal plane) is demonstrated. The solutions obtained are generalized for the case of viscoplastic fluid. A 3D hydrodynamic model of lava dome growth on a slightly non-axisymmetric conical surface is constructed. For finite inclination angles of the surface generatrix to the horizontal, an evolutionary first-order partial differential equation for the free-surface shape is obtained. For point mass supply at the apex of the conical surface and a power or exponential dependence of the entire liquid volume on time, an unique self-similar solution for the free-surface shape and the law of flow front propagation is found analytically. The families of self-similar solutions describing flows with mass sources or sinks at the flow front are also obtained. Non-self-similar regimes of flow on a conical surface with small inclinations to the horizontal are studied numerically. The solutions obtained can be used for describing extrusive and effusive volcano eruptions on curved substrate surfaces. The work received financial support from the RFBR (project 02-01-00067) and from the grant for Leading Scientific Schools (project 1697.2003.1).

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