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Effects of conduit geometry on magma ascent dynamics in dome-forming eruptions

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A 1.5-D steady-state two-phase flow model for magma ascent from the magma chamber through a cylindrical conduit with radius changing with depth is presented. Holding boundary conditions and magma properties constant, we varied conduit geometry systematically, in order to quantify geometric controls on magma ascent dynamics and eruption rate and scale. Conduit widening caused a drop in pressure and corresponding increase in gas volume fraction and magma acceleration, with all changes increasing in magnitude with increasing widening. Compared to changes in geometry, small changes in chamber pressure ($<5\%$) had a weak effect on eruption rate. These findings suggested that conduit geometry (and therefore erosion and accretion of magma along it) may play an important role in controlling eruption rate for effusive eruptions, and provide additional information for interpreting behavior of active lava domes. Many model runs produced a magma plug at the top of the conduit, largely due to permeable gas loss through conduit walls. In general, large radii and low radius ratios (i.e., nearly cylindrical conduits) favor thin, low-density plugs, which may facilitate sudden destruction of a plug, and thus enhance the likelihood of explosive over extrusive eruptions.