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Modeling sill intrusion in volcanic calderas

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We present a numerical model for describing sill intrusion in volcanic calderas. The dynamics of volcanic calderas are often subject to long-term unrests, with remarkable ground deformation, seismicity, and geochemical changes, that do not culminate in an eruption. On the contrary, in some cases, unrests with minor geophysical changes are followed, in few months, by an eruption, as in the case of Rabaul Caldera in 1994 and Sierra Negra (Galapagos) in 2005. The main common features of calderas are the relevant ground deformations with intense uplift episodes, often followed by subsidence. We think that the process of sill intrusion can explain the common features observed on different calderas. In our model, the sill, fed by a deeper magma reservoir, intrudes below a horizontal elastic plate, representing the overlying rocks and expands radially. The model is based on the numerical solution of the equation for the elastic plate, coupled with a Navier-Stokes equation for simulating magma intrusion in the viscous regime. The numerical simulations show that during the feeding process, the ground is subject to uplift. When the feeding stops a subsidence occurs in the central zone. For very low flexural rigidity of the elastic plate, the subsidence can occur even during the intrusion of the sill. The stress field produced by the intrusion is mainly concentrated in a circular zone that follows the sill intrusion front.