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Numerical model for the evaluation of Earthquake effects on a magmatic system.

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A finite element numerical model is presented to compute the effect of an Earthquake on the dynamics of magma in reservoirs with deformable walls. The magmatic system is hit by a Mw 7.2 Earthquake (Petrolia/Capo Mendocina 1992) with hypocenter at 15 km diagonal distance. At subsequent times the seismic wave reaches the nearest side of the magmatic system boundary, travels through the magmatic fluid and arrives to the other side of the boundary. The modelled physical system consists in the magmatic reservoir with a thin surrounding layer of rocks. Magma is considered as an homogeneous multicomponent multiphase Newtonian mixture with exsolution and dissolution of volatiles (H_2O+CO_2). The magmatic reservoir is made of a small shallow magma chamber filled with degassed phonolite, connected by a vertical dike to a larger deeper chamber filled with gas-rich shoshonite, in condition of gravitational instability. The coupling between the Earthquake and the magmatic system is computed by solving the elastostatic equation for the deformation of the magmatic reservoir walls, along with the conservation equations of mass of components and momentum of the magmatic mixture. The characteristic elastic parameters of rocks are assigned to the computational domain at the boundary of magmatic system. Physically consistent Dirichlet and Neumann boundary conditions are assigned according to the evolution of the seismic signal. Seismic forced displacements and velocities are set on the part of the boundary which is hit by wave. On the other part of boundary motion is governed by the action of fluid pressure and deviatoric stress forces due to fluid dynamics. The constitutive equations for the magma are solved in a monolithic way by space-time discontinuous-in-time finite element method. To attain additional stability least square and discontinuity capturing operators are included in the formulation. A partitioned algorithm is used to couple the magma and thin layer of rocks. The magmatic system is highly disturbed during the maximum amplitude of the seismic wave, showing random to oscillatory velocity and pressure, after which it follows the natural dynamic state of gravitational destabilization. The seismic disturbance remarkably triggers propagation of pressure waves at magma sound speed, reflecting from bottom to top, left and right of the magmatic system. A signal analysis of the frequency energy content is reported.