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Numerical Simulation of the seismic waves and compressible fluid motions associated with volcanic eruptions

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We simultaneously calculate the magmatic fluid motions and seismic waves associated with volcanic eruptions, by applying a finite difference method to the basic equations of compressible fluid and elastic motions. We assume a simple reservoir system consisting of a cylindrical conduit connecting with a pressurized chamber. The results show that a shock wave propagates upward from a pressurized magma chamber when a plug between the conduit and chamber is removed. As a result, the chamber deflates causing a contraction of the ground surface with a sinusoidal motion due to a resonance motion of the chamber. When the shock wave reaches the conduit orifice, a high-pressure zone is suddenly built-up, which is theoretically predicted from the Langkin-Hugoniot equation. When the high-pressure is larger than the strength of a lid at the conduit orifice, the lid is removed, and an eruption occurs. Then, a large Rayleigh-wave is excited from the conduit orifice. As the pressure inside the magma reservoir decreases, the ground surface tend to reach the equilibrium. Our simulations indicate that the seismic waves are a very useful tool to detect the fluid motion in the reservoir system and the configuration of the reservoir system. And also, the strength of the lid is a very important role on appearance of the seismic waveforms such as explosion earthquakes and eruption tremor.