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Simulations of gravitational collapse of a magma chamber by means of the distinct element method

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We simulated gravitational collapse of a magma chamber by means of the distinct element method. In the distinct element method, the elements are rigid and their deformation is simulated by element overlap at their contacts. The contact laws that describe the interaction of the elements can assume a variety of forms. Here we apply Hooke's Law for normal and shear forces. Slip of contacts is allowed by limiting the shear force to the product of normal force and surface friction coefficient. In this study, we employed the PFC software of the distinct element method developed by Itasca to the simulations.

The sphere and spheroid were employed as the models of the magma chamber, and the collapse patterns between each model were compared. The resulting box (10 km $*$5 km) is filled with 7200 balls that have radii chosen randomly between 22.5 m and 52.5 m. The ball-ball and ball-wall contacts have normal and shear stifnesses of 30 GN/m and non-cohesive frictional-plastic with a coefficient of frction of 0.58 (Vietor and Oncken, 2005, EPSL). The density of the ball was assumed to be 2500 kg/m^3. The initial stress state was formed by gravitational loading. In the simulations, the rapid reduction of inner pressure of the magma chamber was approximated by deletion of balls in the selected sphere or spheroid region, and the gravitational collapse of the chamber was simulated.

As a result, it was found that the simulations show the same collapse patterns as to the previous analogue experiments, and that the caldera of which radius is smaller than the radius of the magma chamber is formed.