V056-P001 Time: May 28 17:15-18:45

Numerical modeling for caldera formation due to collapse of magma chamber

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We have attempted to estimate a form and formation scale of the caldera due to the drainage of magma by using a numerical simulation.

In this study, we assumed that the caldera would be formed by the collapse of the magma chamber. In the simulations, we approximated the collapse of the magma chamber to the contraction of a small sphere in the elastic medium, and estimated the distribution of the plastic and/or rupturing area due to the collapse of the magma chamber. In addition, we evaluated the effects of the regional stress field for the form and formation scale of the caldera.

In our calculations, we first estimated the 3-D deformation field due to the contraction of the small sphere in the elastic medium, and found the strain field by the numerical differential. In our subsequent calculations, we transformed the strain field to the stress field (local stress field) and superimposed the regional stress field and gravitational effect on the local stress field. Finally, we evaluated the stress field by the Coulomb-Navier yield function under an assumption of the elastic-perfectly-plastic material and estimated the distribution of the plastic and/or rupturing area. In this study, we assumed that the plastic-elastic boundary was the structure boundary of the caldera.

In our results, we found that the plastic area due to the collapse of the magma chamber showed a hollow circle distribution on the surface and a funnelform distribution in the cross section when the regional stress field isn't given or was weak. However, when the strong regional stress field (compression) was given, we found that the plastic area developed in the direction of the maximum compression axis of the regional stress field and showed an oval distribution on the surface. When the regional stress field was an expansion, the plastic area developed in the direction of the minimum extension axis. The plastic area in the cross section showed a funnelform distribution that varied in direction.