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Formation of Complex Crater and its Morphology: Numerical Approach

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Various numerical models of the formation of complex craters, such as, central peaks or rings, are reviewed and our numerical results are presented.

The model of formation of central peak and rings are (1) thermal softening model, (2) acoustic fluidization model, (3) block model, and (4) elastic-plastic model.

The (4) model applies elastic-plastic deformation to the motion of target materials. Beyond the elastic limit, the motion of coagulation of blocky rocks is considered as fluid, even though each rock block has a nature of brittle. Applying Von Mises criterior, central peaks and rings can form.

For the realistic model, processes of cracking and destruction should be taken into account, although the numerical technique is challenging.

In a constant gravity, morphological features of impact craters depend on the size of craters. As the size of crater increases, the shape of the crater changes from a simple ball crater to a complex crater, such as, central peak crater or ring crater. The gravitational force affects the shape of a complex crater, since materials around the wall drive down and those of central crater floor uplift. The uplift of the central peak and the collapse of the peak to ring are observed in the lithology of terrestrial impact craters.

At present, various numerical simulations of the formation of complex craters have been conducted to clarify the mechanics of the formation of central peaks or rings. Several models are advocated. Here, these models are reviewed and our numerical results are presented.

The model of formation of central peak and rings are (1) thermal softening model, (2) acoustic fluidization model, (3) block model, and (4) elastic-plastic model.

(1) is conducted by O'Keefe and Ahrens (1993). The strength of materials is related to the temperature. They also take into consider the geotherm. Thus, Rock materials with the high thermal energy behave as fluid, and result in the uplift of central peaks and its collapse to the ring structure. The problem of this model is that complex craters can form only when the strength of materials is small.

(2) treats rocky materials as Bingham fluid (Melosh, 1989). They assume acoustic (elastic) vibration surrounding the crater cavity, and introduce the periodic pressure variation due to the acoustic fluidization. In this manner, central peaks can be created. The (3) model is similar to the (2) model in the point of view of non-linear rheology taking into consider the vibration of materials. However, both models can never figure out the wavelengths or periods of strong vibration to move materials effectively.

The (4) model applies elastic-plastic deformation to the motion of target materials. Beyond the elastic limit, the motion of coagulation of blocky rocks is considered as fluid, even though each rock block has a nature of brittle. Applying Von Mises criterior, central peaks and rings can form without any thermal softening model.

For the realistic model, processes of cracking and destruction should be taken into account, although the numerical technique is challenging.