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冥王星における衝突盆地の緩和: 内部海存在への示唆
Impact basin relaxation on Pluto: Implications for the presence of a subsurface ocean

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Large-scale topographies, such as impact basins, on solid planetary bodies deform in geologically long timescales. The degree of deformation depends mainly on the viscosity, and the viscosity is strongly controlled by temperature. Consequently, viscous relaxation of large impact basins has been studied to investigate the thermal evolution of terrestrial planets as well as that of icy satellites of giant planets [e.g., 1-4].

Pluto, an icy dwarf planet, is likely to possess large impact basins. In this study, we investigate long-term viscoelastic deformation of impact basins on Pluto which can be compared with forthcoming observational data from New Horizons, the first Pluto explorer.

Although little is known for Pluto, its interior is likely differentiated into a rocky core and an outer H_2O layer [e.g., 5]. The presence of a subsurface ocean, however, is highly uncertain. If the outer (solid) H_2O layer is convective, the radiogenic heat from the rocky core is efficiently transferred to the surface, and temperature of the H_2O layer can be lower than its melting temperature. On the other hand, if the outer H_2O layer is conductive, the heat from the core can melt the H_2O layer. The main controlling factor whether the H_2O layer is convective or conductive is the reference viscosity: the ice viscosity at its melting temperature [6]. In this study, we calculate viscoelastic deformation of impact basins assuming different viscosity profiles and examine the effect of the presence of a subsurface ocean on basin relaxation.

For the initial study, we use two time-independent viscosity profiles; one profile assumes a stiff top shell overlying a thick subsurface ocean, and the other assumes a completely solidified interior. The same viscosity profile in the shell is assumed.

Our results indicate that the instantaneous elastic response largely differ between the viscosity models. However, long-term relaxation does not differ much because it is controlled by the viscosity profile in the shell, which is identical in our calculations. Nevertheless, long-term relaxation strongly depends on the reference viscosity, the main controlling factor whether the shell is convective. Consequently, relaxation state of impact basins can be used to infer the reference viscosity as well as the presence of a subsurface ocean. This result would be applicable to icy satellites of Jupiter and Saturn.

Our next step is to use time-dependent viscosity profiles. To do so, we have modified our relaxation code to take into account the temporal change in the shell thickness. The results will be discussed.

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