Lunar thermal history inferred from viscous relaxation of craters

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Viscous relaxation of a crater is a common phenomenon on icy satellites and many researchers study about it. Viscous relaxation strongly depends on viscosity of the matter that comprises the lithosphere, while viscosity depends on temperature of the matter. In the present day, viscous relaxation does not occur on the moon, because the lunar lithosphere has cooled down, and thus become highly viscous. But in the ancient age when the lithosphere was still hot, the viscous relaxation of a crater is expected to have occurred. If it is possible to estimate the rate of viscous relaxation of ancient craters, we can infer the temperature of lithosphere in the age from the viscosity-temperature relation.

In this study, the viscous relaxation rate of lunar craters was investigated by comparing the depth/diameter ratio of old craters with that of fresh craters. In order to know the real crater depth, the effect of ejecta accumulation was eliminated from the crater depth by using the ejecta thickness map that was newly generated in this study. The estimated rate of viscous relaxation was converted to the surface temperature based upon the viscous relaxation model. As a result, the evidence of viscous relaxation was found in the pre-Nectarian craters. In addition, the estimated lithosphere temperature indicates that the lithosphere temperature in the vicinity of the Procellarum and Imbrium regions (Procellarum KREEP Terrane: PKT) was higher than those of other regions. This result is consistent with the assumption that there is a layer of KREEP elements at the base of the crust in the PKT region.