Topographic degradation of craters on Phobos and the comparison with other small bodies

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The origin of the two Mars satellites Phobos and Deimos is controversial and evolution thereafter is also unclear. A previous numerical study showed that nearly all impact fragments ejected from the inner moon Phobos remain trapped in Mars orbits until re-impact with Phobos. Such ejecta re-accumulation may accelerate topographic degradation of Phobos craters because this process increases the number of small impacts on Phobos. It is expected that, therefore, the degree of crater degradation on Phobos is higher than other small bodies if Phobos has been in the Mars orbit throughout the geologic history of Phobos. In this study, we performed a crater shape analysis based on a topographic diffusion model and estimated the degradation model ages κt (where κ is the diffusivity and t is the crater age) of craters larger than 1 km in radius on Phobos. In addition, similar analysis was performed on craters of the near Earth asteroid Eros, which has the mean diameter and the surface gravity comparable to Phobos.

We find that the distributions of κt are different between these small bodies. The medians of κt are estimated to be $(1.4\pm0.1)\times10^5$ m^2 for Phobos, and $(4.4\pm1.0)\times10^4$ m^2 for Eros, suggesting that the Phobos craters are more degraded than the Eros craters.
The observed high crater degradation rate of Phobos, which is about 3 times higher than that of Eros and the corrected that of Lutetia, implies that the ejecta re-accumulation has occurred throughout the geologic history of Phobos. To evaluate the effect of ejecta re-accumulation, we calculated the total number of craters generated by re-impacts of ejecta from all Phobos craters larger than 1 km in radius. The result shows that the total number of re-impact craters is 2–10 times of the primary impacts, suggests that the high crater degradation rate of Phobos can be explained by the ejecta re-accumulation.

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