

Grooves on Phobos: Results of repetitious impacts of aligned fragments

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Numerous lineaments (grooves) are found on Phobos, but not on Deimos. This might be important to understand the origin and surface evolution of these Martian satellites. Several formation processes of grooves on Phobos have been hypothesized and discussed for years (1-4). However, none of these hypothesized processes can successfully explain the difference in surface expression between the two satellites, which includes the grooves on Phobos and the relatively smooth surface on Deimos.

In this comprehensive investigation, we mapped the grooves by using thousands of images of Phobos to plot each groove on a numerical shape model in order to accurately determine their distribution patterns. We found that all of the identified grooves exist on the corresponding planes, and they could be divided into five trends. This result indicates that the grooves are not due to collapse of the surface of Phobos. We, instead, propose that these depressions are the result of impacts by chains of projectiles; a small body with a rubble-pile structure held together by self-gravity could be pulled apart and stretched into an alignment by tides during the body's close approach to Mars.

Through computer simulations using a N-body numerical code and scaling law, the patterns of pit chains consistent with those observed in the images of Phobos can only be produced when the stretched rubble-pile body orbits about Mars. The effect of the orbital precession of the impactor can explain the five trends. Furthermore, the deficiency of grooves can be explained by this model. Consistent with this hypothesized mode of formation of the observed grooves, intersection of Phobos with impactor composed of < 10 m-diameter fragments can also explain their origin.

References

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