The Shifting Sands of Phobos: Phobos' eccentric orbit triggers landslides on its surface

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The Phobos gravitational environment presents a set of unique conditions to study the complex interactions between a moon and its host planet. Due to its proximity to Mars, Phobos experiences large tidal forces that have likely shaped and altered its surface geology throughout its history. In this study, we explore how Phobos' slightly eccentric orbit (e = 0.0151) causes librations that lead to local variations in surface gravity slopes. These slopes can vary by up to 2 degrees for every orbital period (7hr 39 min).

We will present direct numerical simulations of Phobos' regolith that show that these variations can trigger small landslides in regions that have gravity slopes close to critical values. This presents a new and unique mechanism for regolith mobility on a small body's surface. We use pkdgrav, a parallel N-body code, which simulates the regolith surface of Phobos using spherical particles through a soft-sphere discrete element method (SSDEM). We first calibrate our simulation parameters with the expected range of angles of repose of Phobos material. Then, we show that small variations (1-2 degrees) in the gravity slopes is sufficient to trigger small amounts of mass motion for material that has already experienced granular flow or is close to its angle of repose. By simulating this slope variation over 1 Phobos orbit, we deduce an expected excavation rate (volume flux per unit time) and produce a map of the expected resurfacing rate on Phobos.

We find that high-slope regions that experience moderate-to-high variations in surface slopes are correlated with blue geological units on the moon's surface. In particular, we find that this may explain the mass-wasting features that appear on Stickney's eastern ridge and extends eastward towards the sub-Martian point. Our findings suggest a continual shifting of regolith on the surface of Phobos that transforms its surface by exposing fresh sub-surface material.

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