Fluidization from Continuous Outgassing as a Cause of Ponded Craters and Particle Sorting on 433 Eros

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Abstract

During the Near Earth Asteroid Rendezvous mission, the NEAR Shoemaker spacecraft took high-resolution photographs (some images <1 m/pixel) of several geological structures on 433 Eros. These photographs revealed distinct characteristics of the asteroid, including the presence of pond formations in equatorial craters and particle sorting in other areas of the asteroid. These ponded craters appear to be impact craters that are subsequently partially filled with regolith. The ponded regolith is much younger than the crater itself, implying an impact-independent process for pond creation. Particle sorting can be seen in the regolith lining craters closer to the asteroid poles. Seismic shaking, electrostatic levitation, and fluidization have been suggested as explanations for ponding and particle sorting. When 433 Eros entered a near-Earth orbit, an orbit with a lifetime typically only ~107 years, its surface temperature would have risen by a factor of 2.3. If Eros is composed of up to ~40% subsurface water, as is suggested by its density, fluidization could have begun at approximately that time and would continue until the present. We have performed experiments in a large environmental chamber to explore the possibility of subsurface volatiles emerging from the inside the asteroid, causing continuous fluidization processes that create ponded craters and other particle sorting formations. Using ice and water as subsurface volatiles and JSC Mars-1 martian soil simulant, we have produced structures similar to those seen on 433 Eros. We are currently performing experiments with a variety of volatiles, preexisting craters, and other simulated asteroid terrain in order to see if these results will enhance our understanding of fluidization as a possible cause of the ponded regions particle sorting on 433 Eros.