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Impact cratering on high-porosity planetary bodies

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Porous materials abound in the Solar System. Primordial solids accreted gently from dust into high-porosity aggregates; many asteroids appear to be loosely-bound rubble piles; and the crusts of airless planetary surfaces are heavily fractured from prolonged bombardment of asteroids. High porosity attenuates shock propagation and localizes shock heating, which has several important implications for the evolution of planetary surfaces. Most studies of impact cratering have focused on targets composed of common geologic materials, such as soils and rock, thought to be reasonable proxies for the surfaces of the terrestrial planets. However, it has become clear that those materials are not good analogues for the minor bodies of the Solar System. Here we present numerical and experimental results of impact cratering in high porosity materials that elucidate the compaction regime of planetary cratering: where crater growth is dominated by impactor penetration and compaction, while rapid shock attenuation and extensive collapse limit the volume and speed of ejected material. Understanding these effects is a crucial step in using crater populations to estimate impactor flux, date planetary surfaces and infer subsurface properties, as well as deflecting hazardous near-Earth asteroids.

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