Pounding imparts internal strength to rubble-piles

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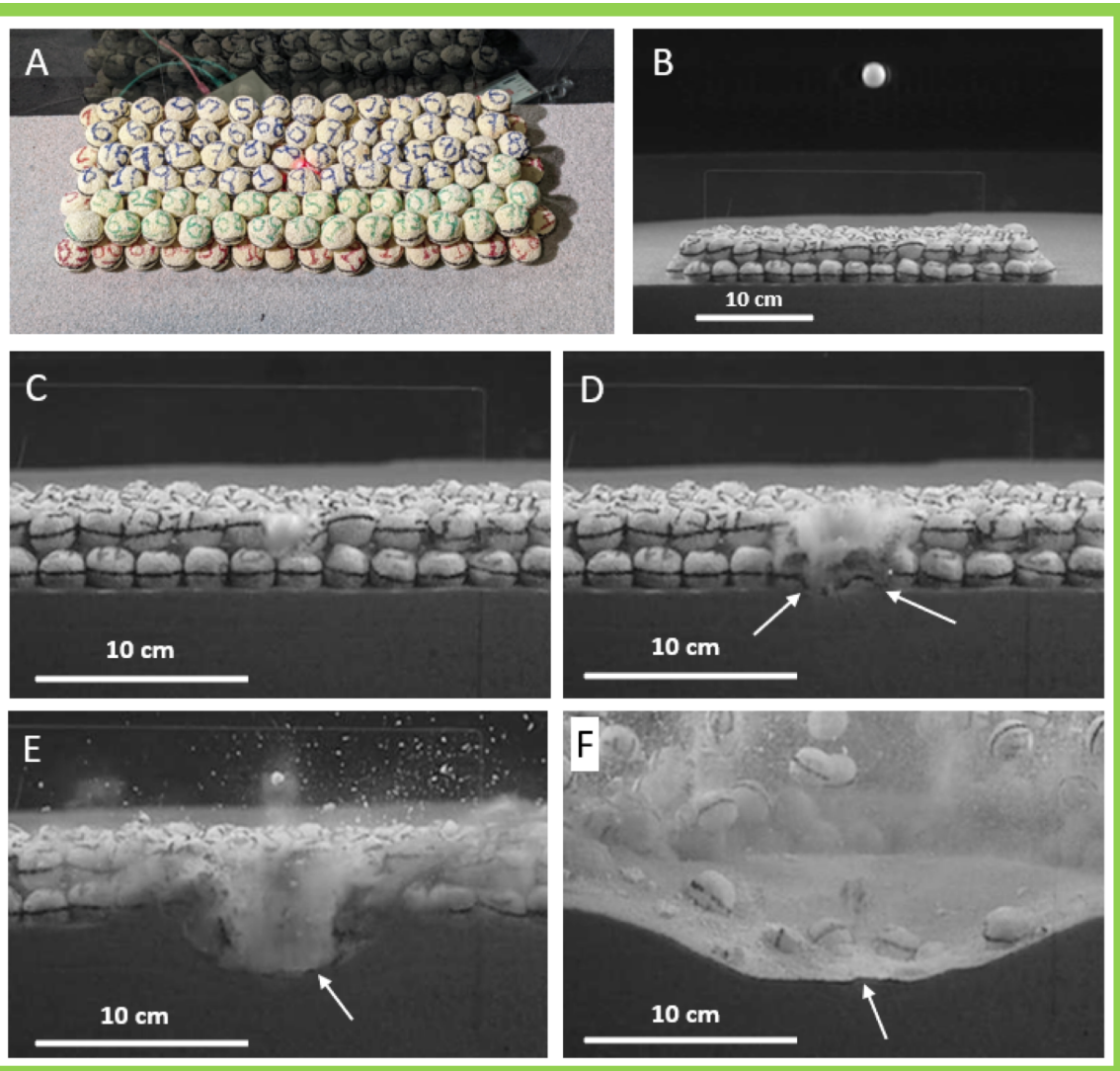

Experimental simulation of an impact into a stratified rubble-pile asteroid. A lrelatively loose layer of boulders cover a finer grained, more compacted substrate. Crushed material is injected down to the floor of the crater developing in the substrate adding material to it. Adapted from Ray et al. (2026).

It is known that nearly all 0.2–10 km, thus frequent, asteroids are "rubble-piles". However, their internal structure remains largely uncertain, but a strength-stratification with a weaker exterior compared with the interior has been suggested for e.g., Bennu. We use projectile impact experiments to explore a possible formation mechanism for this strength stratification. High-speed video recordings show that material from crushed target boulders and projectile rapidly penetrates radially beneath the floor of the expanding cavity in a porous target. Similar features are known from terrestrial impact structures where it penetrates fractures opening in the basement. On a rubble-pile asteroid, repeated impacts over time in a coarse, porous and easily crushable material could lead to accumulation of finegrained, and increasingly compacted, thus stronger, material at depth. Meanwhile, impact-induced seismic activity on the asteroid, causing granular convection, along with rotational centrifugal forces, could promote the segregation of finer material beneath coarser layers, potentially making this effect more pronounced at the poles.
Understanding the internal structure is important when designing space defense asteroid deflection methods such as tested by the DART mission.

ORMÖ, J., HERREROS, M. I., LUTHER, R., WÜNNEMANN, K., RADUCAN, S. D., JUTZI, M., AND PARRO, L. M., 2026: SCIENTIFIC REPORTS, HTTPS://DOI.ORG/10.1038/S41598-026-39893-7.