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Crater morphologies in impact experiments into sandstone

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Impact experiments into sandstone cubes were performed at the two-stage light gas gun facilities of the EMI Freiburg (Schäfer et al., this conference). Spherical projectiles of steel and meteoritic iron were accelerated to velocities of 2.5-8 km/s; impact energies ranging from 0.7 to 58 kJ were obtained. In a detailed study, the processes influencing crater volume, morphology and spall behaviour are investigated through visual mapping, 3D digital modelling and 2D profile analyses. The craters are characterized by an outer, shallow dipping zone with radial fractures and sub-horizontal extensive spall fractures, delineating spall plates. In contrast, the inner crater has steeper slopes and is decorated by light-coloured, fragile, highly fragmented material. Outside the crater, radial fractures sometimes extend from the fractures found within the crater, and in some cases concentric fractures outline areas of incipient spallation. Morphological evaluation of the impact craters with digital scanning methods reveals that crater volume is related to the impact energy by a power law. The cratering efficiency, defined as the ratio of ejected mass to projectile mass, is reduced in porous sandstone in comparison to other, non-porous brittle geological materials. Spallation, as a later-stage cratering process, increases the volume of the transient crater by a factor of 5-10. Constraining the percentage of spallation within a crater and determining the shape and volume of the transient crater are vital for comparison with non-brittle materials like metals, with numerical modelling results, and natural impact craters. Transient crater morphologies are derived from parabola fitted to central depressions of crater profiles, and will be double-checked against ejecta cone angles measured on high-speed captures of the impact.