TRANSIENT CRATER GROWTH AND EJECTA BEHAVIOR IN EXPERIMENTAL IMPACTS INTO GEOLOGICAL MATERIALS.

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Introduction: Impact cratering as a highly dynamic phenomenon can be observed in real-time in impact experiments. We evaluate high-speed videos from two research projects focused on experimental cratering, NEOShield [1,2] and MEMIN [3,4], to gain insights into strength-dominated cratering processes.

Methods: Experiments were carried out at the two-stage light-gas gun facilities of the Fraunhofer EMI in Freiburg, Germany. Aluminum and steel spheres (2-12 mm diameter) were accelerated to velocities of 2-8 km/s and impacted a range of geological targets, including quartzites, sandstones, and porous and non-porous limestones. The impacts were filmed with a Photron camera at $3\text{-}10*10^4$ fps. Using ImageJ image analysis software, initial measurements have been made of the videos.

Crater growth rates were determined by measuring the width of the narrowest part of the ejecta cone, which serves as a proxy for the transient crater diameter [5]. The rate of crater radius growth is given by the power-law exponent μ, which is the slope of scaled crater radius vs. scaled cratering time (see [5]). Also, ejecta cone angles were estimated, and particle velocities of ejected projectile fragments were measured.

Results: A general evaluation of the videos shows an initial "plume" of incandescent material in some experiments. The occurrence and duration of the plume is correlated to (increasing) projectile velocities and sizes, as well as target porosity. Target material is excavated in an ejecta cone, which transitions into a tube-like ejecta flow perpendicular to the target surface. This may mark the transition from "crater excavation" to strength-dominated modification processes, and occurs ~100-200 µs after the impact.

Crater growth rates as defined by their μ-values generally increase with increasing impact velocities for all target types. Growth rates decrease with increasing porosity, and data suggest that larger projectiles sizes can lead to increased growth rates.

Ejecta cone angles measured to the target surface decrease with porosity, as described in [5,6] but show an increase with impact velocity, in contradiction to [6,7]. The reason for this is currently not understood.

A large projectile remnant (≤~50% of impactor) is sometimes ejected perpendicular to the target surface at speeds of ~200-300 m/s. Back-calculation of flight paths shows that the ejection must have occurred ~1-2 µs after impact. This may be the result of spallation at the back of the projectile, and, in this case, may require reconsideration of how much momentum and energy of the impactor is transferred or coupled to the target.

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