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Experimental impact cratering: The MEMIN project

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To comprehensively understand the dynamics of impact processes and to quantify the properties of impact-damaged rocks a ***M***ultidisciplinary ***E***xperimental and ***M***odeling ***I***mpact crater research ***N***etwork (***MEMIN***) was recently established that involves geologists, geophysicists, engineers, and modelers. Prime goals of the project are (i) the experimental validation of hydrocodes and material models to simulate impact processes and, (ii) the understanding of geophysical anomalies which characterize natural impact craters. The experimental program performed at the Ernst-Mach Institute (Freiburg, Germany) is designed to achieve crater sizes in the decimeter-range in consolidated rocks. With the operation of a two-stage light gas gun as the most versatile accelerator, velocities of 5-6 km s^{-1} for projectile masses of a few grams, and up to 10 kms^{-1} for milligram projectiles are attainable. The experimental procedure comprises the recording of physical parameters during the experiment and the complete acquisition of property changes (petrography, petrophysics) of the target in the crater´s spatial context. These data provide the “ground truth” for the validation of numerical models.

Experiments: Two pilot experiments [1] with a two-stage light gas gun have been conducted with sandstone targets (see also companion abstract by *Kenkmann et al.*, this volume). Steel spheres with a diameter of 10 mm and a mass of 4.1 g were launched against blocks (1.0 x 1.0 x 0.5 m) of sandstone enclosed in a steel frame. One of the blocks had a water saturation of about 44 % of the pore space. Petrographical and geochemical composition, grain size, porosity, fluid saturation, and strength of the rock were determined before the impact. For technical reasons the blocks were positioned vertically to simulate a vertical impact onto flat-lying sediments. Ejecta catchers consisting of fiber-boards were installed parallel to the target surface at a distance of 55 cm. A high-speed camera documented the excavation in 16 photographs taken over a period of 1.2 msec. Pressure gauges recorded shock pressure at the rear and sidewall of the blocks. Numerical simulations were used to estimate the crater structure and shock pressures before the experiments.

Results: The impact velocity for both experiments was $\sim$5.3 km s^{-1}. The high-speed photographs yielded the residual velocity of the ejecta material, the angle of the ejecta cone and an estimation of the beginning of spallation during the cratering process. The gauges provided valuable data for simulation models. The resulting craters had diameters of 24.3 and 28.7 cm and depths of 5.6 and 4.5 cm for the dry and wet experiment, respectively. Differences in shape and size of the craters and in the average ejection may indicate that the presence of pore fluids influences the cratering process in sandstone.

References: [1] Thoma, K. et al. (2005), Met. Planet Sci., 40 (9), # 5049, A 155.