IMPACTS INTO SANDSTONE: POROSITY EFFECTS IN THE STRENGTH REGIME.

M. H. Poelchau[1], A. Dufresne[1], T. Kenkmann[1], and the MEMIN Team. [1]Instut für Geowissenschaften, Universität Freiburg, Germany (michael.poelchau@geologie.uni-freiburg.de).

Introduction: The MEMIN (Multidisciplinary Experimental and Modeling Impact Research Network) is currently focused on experimental impact cratering into sandstone. One of the main goals of these experiments is determining the role porosity has on the impact process and on the resulting crater morphology. So far, four sets of impact experiments have been performed at the two-stage light gas gun facilities of the Ernst-Mach-Institut, Freiburg, Germany. Aluminum, steel and iron meteorite projectiles were accelerated to velocities between 2.5-7.8 kms^{-1}, resulting in impact energies ranging from 0.7-58.4 kJ. Targets were dry Seeberger sandstone blocks with a grain size of ~70 µm, a porosity of 20-25%, and a uniaxial compressive strength (UCS) of 35-40 MPa [1-2].

Cratering results and discussion of porosity effects: All crater dimensions were measured with a 3D laser scanner. Crater depth to diameter ratios range from 0.14 to 0.25. Craters formed by steel or meteoritic iron projectiles are slightly deeper (0.20) than the average craters formed in crystalline rocks with similar high-density projectiles (0.18) [3-4], indicating that the sandstone's porosity results in slightly increased penetration depth. The sandstone craters formed by aluminum projectiles, on the other hand, are much shallower (0.15), and thus reflect a stronger dependency of penetration depth on projectile density than on porosity, at least for porosity values of ~25%.

The effect of porosity becomes more apparent when crater volumes of the sandstone and non-porous crystalline rocks [3-5] are compared. For the same impact energy and roughly similar impact conditions (projectile mass, density and speed) the same crater volumes result, in spite of a difference of target crushing strength of nearly one order of magnitude (UCS of crystalline rocks is assumed at 300 MPa). This is in agreement with numerical modeling results [6] that show a dampening of the shock wave through porosity. Thus, the amount of energy available to work against the target's strength to form a crater is reduced by the work required to close pore space. Although density effects of the projectile on crater volume should be expected, no major differences were detected.

The cratering efficiency (the ratio of excavated target mass to projectile mass) in sandstone is also greatly reduced compared to strength scaled cratering efficiency values of crystalline rocks [3-5] by almost one order of magnitude. Based on the limited number of data, it is currently difficult to determine the exact effects of porosity on strength-scaled size parameters beyond a general reduction of cratering efficiency. Impact experiments into more highly porous target rocks are planned to better quantify the effects porosity has on cratering in strength dominated regimes.

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