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MEMIN - Hypervelocity Impact Cratering Experiments into Sandstone: Initial results

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The Multidisciplinary Experimental and Modeling Impact Research Network (MEMIN - DFG Research Unit [1]) was set up in order to generate a better understanding of impact cratering processes at different projectile scales, and as function of impact velocity in dry and wet sandstone lithologies. This is achieved by thorough analysis of highly instrumented hypervelocity impact experiments [2], shock Hugoniot data of the involved material, and hydrocode simulations. First experiments were carried out with Seeberger sandstone of ∼18 % porosity [3]. Projectiles are made from steel, the iron meteorite Campo del Cielo, and aluminum alloy spheres with diameters of 2.5 mm, 5 mm and 1 cm, accelerated to velocities between 2.5 km/s and 7.8 km/s using EMI's two-stage light-gas guns [4].
Experiments on sandstone, involving 1 cm diameter steel spheres impacting at 5.3 km/s indicated an increase in cratering efficiency [2, 3, 5] by more than 30% by the presence of water in the sandstone pores compared to the dry sandstone. Crater morphology and comminution of target material in the crater are analyzed in depth in [6] and [7]. Further topics under investigation comprise the time evolution of the penetration and crater formation process, and the dynamics of ejecta cloud formation and propagation, as function of water saturation of the target sandstone, and numerical modeling of the experiments. Peak shock pressure measurements have been performed in the bulk target material employing shock-pressure gauges buried 45 cm below the impact location. The signals recorded have shown that the peak shock pressure in the wet sandstone is about one order of magnitude lower than in the dry sandstone. Simultaneously, it was observed that the initial fragment ejection velocities in wet sandstone as derived from high-speed video are significantly exceeding those of dry sandstone by up to 50% [2]. A ground breaking observation is the transformation of the conically shaped ejecta cloud during the early excavation phase into a tube-like stream of ejecta particles at a later stage of the process (deep excavation) [8]. It is not clear yet whether the same quantitative and qualitative behavior occurs for wet sandstone. Ejected matter captured with newly designed catchers placed in uprange direction revealed that the early ejecta are located on an outer ring and are very finely fragmented while the late ejecta are concentrated around the impact axis, consisting of rather large chunks of target material, including spall fragments of the target [9]. To better understand the shock behavior of dry and wet sandstone, and to derive shock-Hugoniot data from the material for hydrocode simulation [10], recently a series of shock recovery tests using dry sandstone material [11] and flyer plate tests have been performed at EMI.
Summary: the differences between the behaviour of dry and wet porous sandstone under hypervelocity impact are significant, and require further extensive investigations of the causes.

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References
[1] Kenkmann T. et al. (2006) LPSC XXXVII, Abs. # 1587. [2] Schäfer F. et al. (2006) ESA SP-612. [3] Kenkmann T. et al. (2011) MAPS, in review. [4] Poelchau M. H. et al. (2011) LPSC XLII, Abs. # 1824 [5] Kenkmann T. et al. (2011) Proc. 11th HVIS, No. 112, in press. [6] Dufresne A. et al. (2011) GRA 13, this volume. [7] Buhl E. et al. (2011) GRA 13, this volume. [8] Hoerth T. et al. (2011) LPSC, XLII Abs. 1993. [9] Reiser F. et al. (2011) LPSC, XLII Abs. # 1733. [10] Güldemeister N. et al. (2011) LPSC XLII, Abs. # 1104. [11] Schmitt R. T. et al. (2011) GRA 13, this volume.