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MEMIN - sidestep: a cratering experiment into limestone

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Sediments and sedimentary rocks are a common target in terrestrial cratering. Of the >175 known impact structures on Earth, ∼60 have mixed crystalline – sedimentary target, and ∼65 have been formed in a pure sedimentary target. In this context, carbonates play an important role as they can dissociate after release from high dynamic pressure, releasing CO2 as climate forcing gas [1]. The Chicxulub impact at the K/Pg-boundary is the most spectacular example for this process. Stages of progressive shock metamorphism of carbonates are documented well in qualitative manner [2]. Some of the features have been reproduced in shock recovery experiments with different set-ups using planar shock waves [3]. Notwithstanding, the overall knowledge of impact metamorphism of carbonates, and cratering into solid limestone is limited. Within the frame of the MEMIN-Project (Multi-disciplinary Experimental and Modeling Impact Research Network [4-6]) we have performed a reconnaissance cratering experiment (K1#5184) with a 20 x 20 x 20 cm block of “Treuchtlinger Marmor” (Malm Delta quarried at Gundelsheim; average density 2.61 g/cm^3, compressive strength 149 MPa, porosity 3.7 vol-%), dried on air. Such massive thick bedded White Jurassic limestone was one of the target lithologies of the Ries impact event. The cratering experiment was performed with the SLGG (“space” light gas gun) of the Ernst-Mach-Institut (EMI), Freiburg, using a spherical steel D290-1 projectile (D 2.5 mm) accelerated to an impact velocity of ∼5 km/s (corresponding to a kinetic energy of 952 J), with the target chamber evacuated down to 100 mbar [5, 6]. The produced crater has a maximum depth of 1.1 cm, and a diameter of 6.75 cm, including the about 2 to 2.5 cm wide spallation zone at its outer edge. The volume calculated from difference in weight (prior/after the experiment) suggests a total crater volume up to ∼10 cm3. This yield compares well with results for cratering experiments in crystalline rocks (see [7] for details).
Currently we evaluate ejecta, material on the crater floor, and the damage in the sub-crater floor with various X ray, optical, and electron optical techniques, using oriented samples.

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