SHATTER CONES FORMED IN A MEMIN IMPACT CRATERING EXPERIMENT.

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Introduction: Shatter cones are important shock indicators - the only, that can readily be identified on the macroscopic scale. They are, therefore, an important diagnostic tool to confirm ancient eroded impact craters [1]. However, there is still no consensus of how shatter cones form, e.g. [2-5]. For instance, it is controversial if the fractures surfaces are the result of shear or tensile failure. Likewise the shock pressure interval required for their formation is a matter of debate. Experimental analysis combined with micro-structural investigations is a promising avenue to constrain the physical boundary conditions and the failure mechanism that lead to shatter cone formation. Experimentally formed shatter cones produced in limestone are reported, e.g. by [6]. Here we present shatter cone formed in a MEMIN impact cratering experiment in sandstone (Exp. A15-5185).

Experiment: Utilizing a two stage light gas gun (40 mm caliber, 1.8 m long pump tube combined with an 8.5 mm caliber, 1.5 m long launch tube) of EMI-Freiburg we fired a 5 mm aluminum projectile (0.1792 g) at 7 kms^{-1} against 20 cm sized cubes of dry "*Seeberger Sandstein*", a well sorted, quartz-rich sandstone of 100 µm mean grain size and 23 % porosity [7]. Impact energy and peak shock pressure were 4353 J and 70 GPa, respectively. The obtained crater dimensions were 10.5 cm diameter, 1.43 depth, 0.14 depth-diameter ratio, and 42.9 cm^3 crater volume. The central depression of the crater cavity displays a small central dome composed of pulverized quartz. Shatter cones of a several millimeters to half centimeter size were recovered from the ejecta. They display typical morphologies including apices, diverging striae and grooves on conically shaped surfaces. Microstructural investigations of the shatter cone surfaces at the scanning electron microscope show that highly vesicular melt films alternate with smooth polished surfaces that may also consist of amorphous material. The surfaces indicate shear off sets; vesicular melt predominantly forms where releasing steps on the surface occur. The shatter cones developed in shock-deformed sandstone whose porosity was crushed prior to the shatter cone formation. This indicates that shatter cones develop at the trailing end of shock compression.

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