JETTING IN EXPERIMENTAL IMPACTS. F. D. Sommer[1], R. Winkler[1], M. H. Poelchau[1], A. Deutsch[2] and T. Kenkmann[1], [1]Institute of Earth and Environmental Sciences - Geology, Albert-Ludwigs-Universität Freiburg, D-79104, Freiburg, Germany (Frank.Sommer@geologie.uni-freiburg.de), [2]Institut f. Planetologie, Westfälische Wilhelms-Universität Münster, D-48149 Muenster, Germany.

Introduction: Jetting occurs in the earliest stage of an impact event when molten or vaporized material is released with a velocity higher than the impact velocity. On high-speed videos of experimental impacts this phenomenon can be observed as a flash of light. In natural impacts remnants of this process occur as up to centimeter-sized aerodynamically shaped glass bodies in strewnfields several hundred kilometers off the impact point. We were able to collect and analyze this type of ejecta in our MEMIN experiments. Whereas the meteoritic component of tektites is very low [1], our results display a broad variety of compositions which must be explained.

Methods: In the MEMIN experiments steel projectiles with a diameter of 12 mm were shot with a velocity of 4600 m s^{-1} on sandstone and quartzite targets. In addition to the ejecta catcher opposite to the target surface, a jetting-catcher covered with 5 mm of Vaseline was mounted at an angle of 10° to 30° to the target surface (Fig. 1). The material extracted from the jetting-catcher was examined under a scanning electron microscope equipped with energy dispersive X-ray spectroscopy (Zeiss LEO 1525 with EDX) at our Institute in Freiburg.

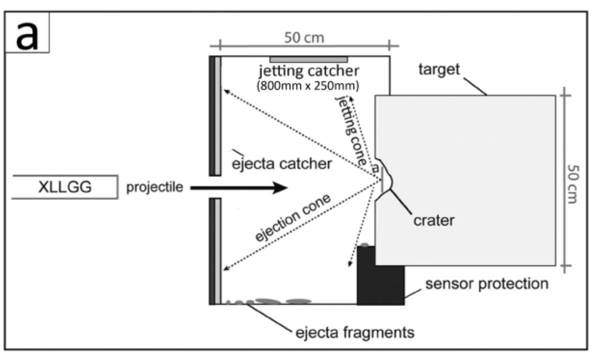

Fig. 1: Experimental setup: The target surface is enclosed in a plywood box to contain the impact ejecta. The Vaseline-coated jetting-catcher is fixed to the ceiling of the box to capture early high-speed jetting particles. XLLGG: extra large light gas gun, EMI Efringen-Kirchen.

Results: A large number of glass-like spherical particles between 0.5 to 5 µm in diameter was found in the sandstone experiment (Fig. 2). They are composed of Fe and Mn from the projectile and Si from the target in various proportions (Fig. 3).The surface of some particles display possible fast cooling structures (Fig. 3) and are covered with spheres ~ 100 nm in size (Fig. 4). In the experiment with a quartzite target, the jetted particles reach a diameter of 15 µm and show a more elliptical form.

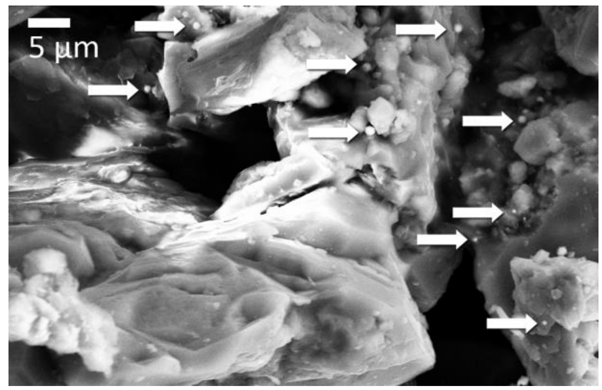

Fig. 2: Small spherules of jetted sandstone (arrows) appear among coarser quartz particles ejected in the later impact phase,

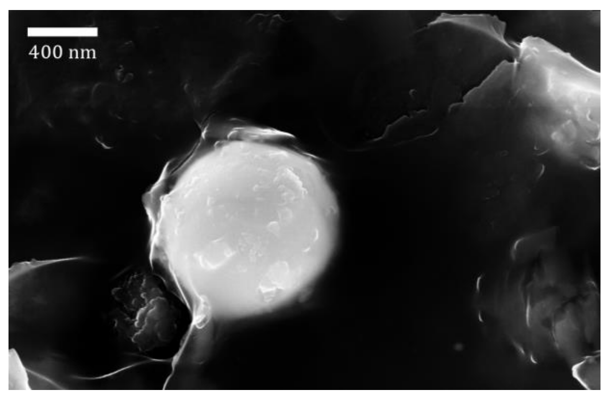

Fig. 3: Jetting spherules display possible fast cooling structures.

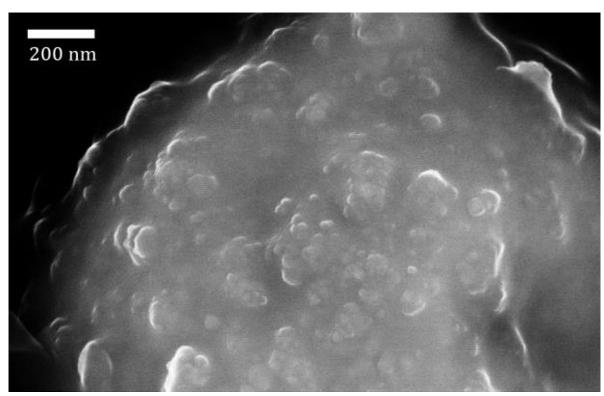

Fig. 4: On the surface of the particles small spheres are attached.

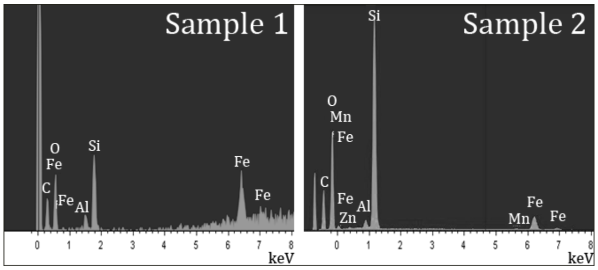

Fig. 3: Semi-quantitative energy dispersive analyses of two jetted particles.

Discussion: The jetting particles are expected to be ejected at angles between 15° to 40° to the target surface [2] which is true for our experiments. This type of “jetted” particles were not found in the ejecta catcher. Concerning the particle diameter (d_0), Melosh and Vickery [3] proposed a formula based on the balance between surface tension of the molten material and the local kinetic energy: $d_0 = (40\delta/\rho_{target})^{1/3} (L/v_{impact})^{2/3}$ (strength: $\delta = \approx 0{,}3$ N m^{-1} for silicate liquids; density: $\rho_{target} = 2600$ kg m^{-3} for quartz, projectile size: L = 12mm and impact velocity: $v_{impact} = 4600$ m s^{-1}). The calculated diameter of about 20 µm for our experiments is in good agreement with the observed particle diameter of 0.5 to 15 µm. The particle mass correlates with the data expected from natural [4] and experimental impacts [5] and to the results of numerical models [4]. The particle shape, including the surface pattern, correspond to the appearance of tektites: glass-like structure, spherical shape in sandstone, aerodynamic ellipsoid shape in quartzite. The broad variety in composition was not expected since tektites display a low content of projectile material [1].

Outlook: We will further improve the design of the jetting catchers to prevent possibilities of contamination of the catcher assembly by late–stage turbulent ejecta.

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