THE CANYON DIABLO IMPACT EVENT: THE PROJECTILE FATE

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Introduction: Mass and impact velocity estimates of the Meteor crater projectile varied widely, starting from the historical Barringer's hypothesis of a huge body comparable to the crater size buried beneath the crater floor [1] to modern scaling law values [2] giving a rather modest diameter of ~40 m for an 18-km/s impact velocity. Our recent study of the projectile disruption and deceleration in atmosphere [3] suggests that the most probable pre-atmospheric mass was ~10^9 kg, corresponding to 68-m-diameter spherical iron projectile (and 18 km/s impact velocity). Approximately 50% of this mass was lost during atmospheric entry because of ablation and disruption into small fragments (the Canyon Diablo meteorites) dispersed over the impact region. While these fragments landed with low velocities (and survived as meteorites), the main cloud impacted the surface with velocity of ~15 km/s. The possibility of lower impact velocities cannot be totally excluded, as some NEOs have low pre-atmospheric velocities [4].

Projectile inventory: meteorites, spheroids, and shale balls. By the early 1900s, thousands of iron meteorites, ranging from less than 25 g to more than 500 kg in weight, were collected within a radius of 5.5 miles from the crater [5]. Meteorites on the plains show clear Widmanstätten figures. Irons recovered near the crater rim show evidence of strong heating, up to partial melting and recrystallization. Tiny spheroids (< 1 mm) are abundantly distributed within ~8 km from the crater mainly in the northeast direction and are sorted with distance, with the largest spheroids located on the crater rim [5,6]. They may be the condensation product of the partially vaporized part of the projectile.

Model. To model the cratering process we use the 3D SOVA hydrocode with particles [7]. Material strength is taken into account using the rigid-plastic approximation. A moderately dispersed projectile strikes the target with lithology similar to the Meteor crater region (from top to bottom: Moenkopi, Kaibab, Coconino). The water table at a depth of 150 m can be taken into account to describe additional ejecta dispersion by a water vapor [8]. SOVA is coupled to tabular equations of state for iron (projectile), quartzite and calcite (sedimentary rocks), and water.

Results: Our results on shock compression of the projectile confirm previous results [9]: little vaporization, some melting, while over 50% of the impactor remains solid, although strongly compressed and heated, and is ejected from the crater. We can connect the projectile shock compressions and ejection velocities with the distribution of irons around Meteor Crater. The mass inventory shows that a lot of the projectile material was removed from the crater area before its scientific study began.

References: [1] Barringer D.M. 1909. Paper read before Nat.Acad. Sci. [2] Schmidt R. M., Housen K. R. 1987. *Int. J Impact Eng* 5: 543–560. [3] Artemieva N. and Pierazzo E. 2007. *M&PS*, submitted. [4] Bottke W. 2002. *Icarus* 156: 399-433. [5] Nininger 1973. Find a falling star, 254 p. [6] Rinehart J.S. 1958. *Smiths. Cont. Astroph.* 2: 145-159. [7] Shuvalov V. 1999. *Shock waves* 9:381–390. [8] Artemieva N. (2007) M&PS, in press. [9] Schnabel C et al. 1999. *Science* 285: 85-88.