SHOCK07-2007-020057

Abstract for an Invited Paper
for the SHOCK07 Meeting of
the American Physical Society

The Deep Impact Oblique Impact Experiment

PETER H. SCHULTZ, Department of Geological Sciences, Brown University, Providence, RI 02912-1846

The Deep Impact experiment represents a unique challenge. Without being able to see clearly the final crater, properties of the target requires comparing the ballistic ejecta with analytical and theoretical models for crater excavation. But the appropriate excavation model needs to be identified first. Consequently, each critical stage of cratering observed for the DI collision (initial coupling, late-stage ejection) is described and compared with a wide range of laboratory experimental results. The early-time flash and vapor plume rapidly evolve along the trajectory: an initial faint "first light" uprange from the projected point of impact; a fading source along the trajectory that moves downrange ($\sim$100-170m) over the next 0.125s after impact; gradual brightening over the next 0.62s; and then a sudden "flash" (saturated pixels) around 0.25s after the "first light." This evolution is consistent with a high-porosity, layered target, which is also inferred from the high-resolution imaging of the impact point. Because of the low impact angle for DI (between 25° and 35° from the surface horizontal), changing styles of ejecta with time are mapped out spatially by the ballistic ejecta. Such changing styles provide qualitative but critical clues for scaling including initial coupling (plume evolution, shallow versus deep coupling) and excavation stages (symmetric versus asymmetric, non-radial rays). Two different approaches are used to constrain the final crater size: backward ray traces to the surface and estimates derived from the total ejected mass from earth-based telescopic observations. Ejecta ray traces indicate a diameter of about 175m. The total ejected mass based on Earth-based observations (107 kg dust and water ice) should be 50 times less than the total displaced mass for the crater (neglecting the contribution by ices). Based on this (and other considerations), the crater diameter could be a maximum of 250m. Nevertheless, the excavated mass observed from the earth (or other probes) most likely was derived from a very small fraction (and likely the upper surface) due to the oblique trajectory. The crater may very well be a nested crater, i.e., a deep penetration funnel surrounded by a shallow excavation crater.