PROGRESSIVE IMPACT CRATERING

R. A. De Hon, Department of Geosciences, Northeast Louisiana University, Monroe, LA 71209.

Most cratering experiments are designed to study the effects of a single hypervelocity impact into a target of uniform properties (1). Experiments involving multiple impacts are usually limited to low velocity projectiles and unconsolidated target materials. Gault (2) described saturation cratering in an unconsolidated target. Quaide and Oberbeck (3) studied crater forms produced by hypervelocity impact into layered targets. Several investigators (4, 5, 6) have modeled the generation of either a regolith or a megaregolith by repeated impact on planetary surfaces.

Studies now in progress examine changes in crater morphology and target properties by repeated impact into an initially consolidated target. Current studies employ low velocity projectiles (2 g at 0.5 km/sec) and consolidated salt targets. Records of crater size, morphology, and accumulated ejecta thickness are maintained as impacts collect on the surface.

Initial impacts into the target block produce simple, bowl-shaped craters (approximately 3.2 cm diam. and 1.5 cm deep) with minor structural rims. During this early stage of cratering, while impacts are essentially in unaltered target material, all ejecta is fine-grained. Once crater saturation is reached and impacts begin to impinge on previously formed craters, large blocks of ejecta begin to dominate the growing ejecta mantle. At this later stage, craters tend to be 2 to 5 times larger than the initial craters and exhibit irregular morphologies. The overall morphology is largely controlled by the irregular thickness of the ejecta mantle, the irregular boundary between solid substrate and concomitant mantle, and the distribution of large blocks within the ejecta mantle. Continued impact comminution of the surficial materials by repeated impact reduces the population of large blocks and increases the thickness of the surficial mantle by bulking of ejecta and continued quarrying of the substrate.

In the final stages, the ejecta mantle reaches a steady state, average thickness. Further impacts do not affect the solid substrate. The mantle thickness is locally variable as new impacts redistribute surficial materials. In this final stage of cratering, craters acquire classic bowl-shaped morphologies with well-defined ejecta rims. The overall crater dimensions increase to nearly 10 times the size of the initial craters in an unmodified target material.

Current studies are obviously constrained by experimental conditions to strength craters formed by a single impact energy at terrestrial gravity and atmospheric pressure. Nevertheless, these experiments shed light on the interaction between crater-forming processes and alteration of the target as impacts accumulate on the surface. At this scale, crater morphology is strongly controlled by irregular development of the surficial layer. The non-uniform nature of surface topography, mantle thickness, and substrate boundary layer precludes the development of a characteristic progression of crater forms as a simple function of increasing mantle thickness with time.

References

(1) Gault D. E. *et al*. 1968, in Shock Metamorphism of Natural Materials, Mono Book Corp., p. 87-99.
(2) Gault D. E. 1970, *Radio Sci*., 5, 273-291.
(3) Quaide V. L. and Oberbeck V. 1968, *Journ. Geophys. Res.*, 73, 5247-5270.
(4) Hartmann W. K. 1973, *Icarus*, 18, 634-639.
(5) Head J. W. 1976, *Proc. Lunar Sci. Conf. 7th*, 2913-2927.
(6) Housen K. R. *et al*. 1979, *Icarus*, *39*, 317-351.