A NEW MODEL FOR FRESH SIMPLE CRATER SHAPES FROM THE LUNAR MARIA

John E. Chappelow

INTRODUCTION -

- The widely accepted shape model for fresh simple craters - that they are ~parabolic and have depths (d) of about one fifth of their diameters (D) - has now been shown to be rather inaccurate [1,2,3,4].

- Using shadow measurements, Chappelow [1,2] found that most simple craters on Mare Serenitatis are shallower than d/D = 0.20 and are not parabolic but hyperbolic - a shape intermediate between a parabola and a cone.

- Similarly, Linné crater (right) has long been taken as the type example for fresh simple craters.

- However, [3,4] showed that Linné too is not ~parabolic but hyperbolic, considerably deeper than d/D = 0.20, and with a small flat bottom:

- Thus a better (yet still simple) model for simple craters than the parabolic ideal or Linné crater would be useful, and is the goal of this work.

METHODS -

- The shapes of 64 fresh simple craters (0.5 < D < 7.0 km) on the lunar maria were determined using the Free Shadowfront Method (FSM) [4,5].

- The FSM yields crater depth, diameter, and the eccentricity (e) of its conic-sectional shape, from measurements of shadows cast within them by the Sun (Fig. 3).

- Craters were selected via several criteria, but primarily by the presence of bright ejecta halos surrounding them (see Fig. 1) and measured using the FSM.

RESULTS -

- The mean conic-sectional shape of all 64 craters is given by e = ~1.87 (Fig. 4).

- A dichotomy is observed between craters larger/smaller than D = ~2.5 km. Smaller craters have greater variation in both e and d/D and average ~15% shallower than larger craters (d/D = ~0.23 vs. ~0.29).

- Most of the larger craters (11 of 13) also contain sizeable flat floors while very few smaller ones do, and these are much smaller.

- Thus the new crater shape model comes in two parts:

  \[ z(r) = z(0) + r^2 \left( \frac{1}{e} \right) \]  

  where the origin is at the crater bottom, r is the radial distance from the origin, and z(0) is the height above the datum.

- These are both equations of hyperbolas (Fig. 5).

CONCLUSIONS -

- The currently existing, parabolic model for fresh simple impact craters does not accurately reflect these craters true shapes (Figs. 2 and 4).

- Linné crater, which is currently considered the type example for fresh simple craters, is closer, but still leaves room for improvement (Figs. 4 and 5), and its shape has not yet been reduced to an algebraic expression.

- A new simple, analytic model for small, fresh simple craters on the lunar maria is presented herein.

- Using Fig. 4, two craters were identified which better represent the population of these craters on the Moon: A ~1.4 km crater at 24.45°N, 328.12°E (Fig. 6a) and a ~2.7 km crater at 31.35°N, 296.46°E (Fig. 6b).

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