STUDIES OF EARLY INTENSE CRATERING AND POSSIBLE SATURATION EFFECTS

William K. Hartmann
Planetary Science Institute, Tucson, Arizona

Crater counts on Rhea were completed, to be compared and combined with independent counts by Steve Squyres; the material is now being integrated into a study of cratering on Rhea and other Saturn satellites by Squyres, Lissauer, and Hartmann. Special attention is being paid to lighting and other effects on the apparent changes in crater density from one region to another.

In my 1984 Icarus paper, "Does Crater Saturation Equilibrium Occur in the Solar System," I proposed that a common steady state density has been reached on a number of different planets' and moons' surfaces, at a number of different crater-diameter-scales. This crater density is given (within a factor 2 or 3) by the equation

$$\log N_{HC} = 1.83 \log D_{km} - 1.33$$

where N_{HC} = crater density in heavily cratered regions (craters/km^2)

expressed as craters in $\sqrt{2}$ logarithmic increments of diameter.
and D_{km} = crater diameter in km.

I proposed in that paper that a further test of the concept could be made by seeing if sub-hectometer-scale lunar craters, which are widely regarded as being saturated, in order to explain the regolith, match this curve. This is a sensitive test, because at scales from about 2 km down to a few hundred m, these craters fall on a steeply ascending curve with slope near -3, rather than the slope of -1.83 found in the equation above. Therefore, if they fit the saturation curve, we will find a dramatic "roll-over" from the steep branch to the flatter -1.83 branch described by the equation. My preliminary results indicate that this roll-over is found. One example is shown in Figure 1, where the craters in Mare Cognitum are shown down to diameters of a meter. Segment A is the under-saturated set of large primary impacts formed in the last 3-1/2 billion years. Segment B is the steep secondary branch. It can be seen that B rolls over sharply at about 300 m to segment C, which falls along the curve described by the equation.

This result is unexpected according to those who assert that there is no saturation, and it has profound implications for re-interpretation of Voyager results on outer planet satellites, where the Voyager team interpreted all surfaces as being not saturated. This new result raises the possibility of saturation and, therefore, changes in their estimates of crater origin.

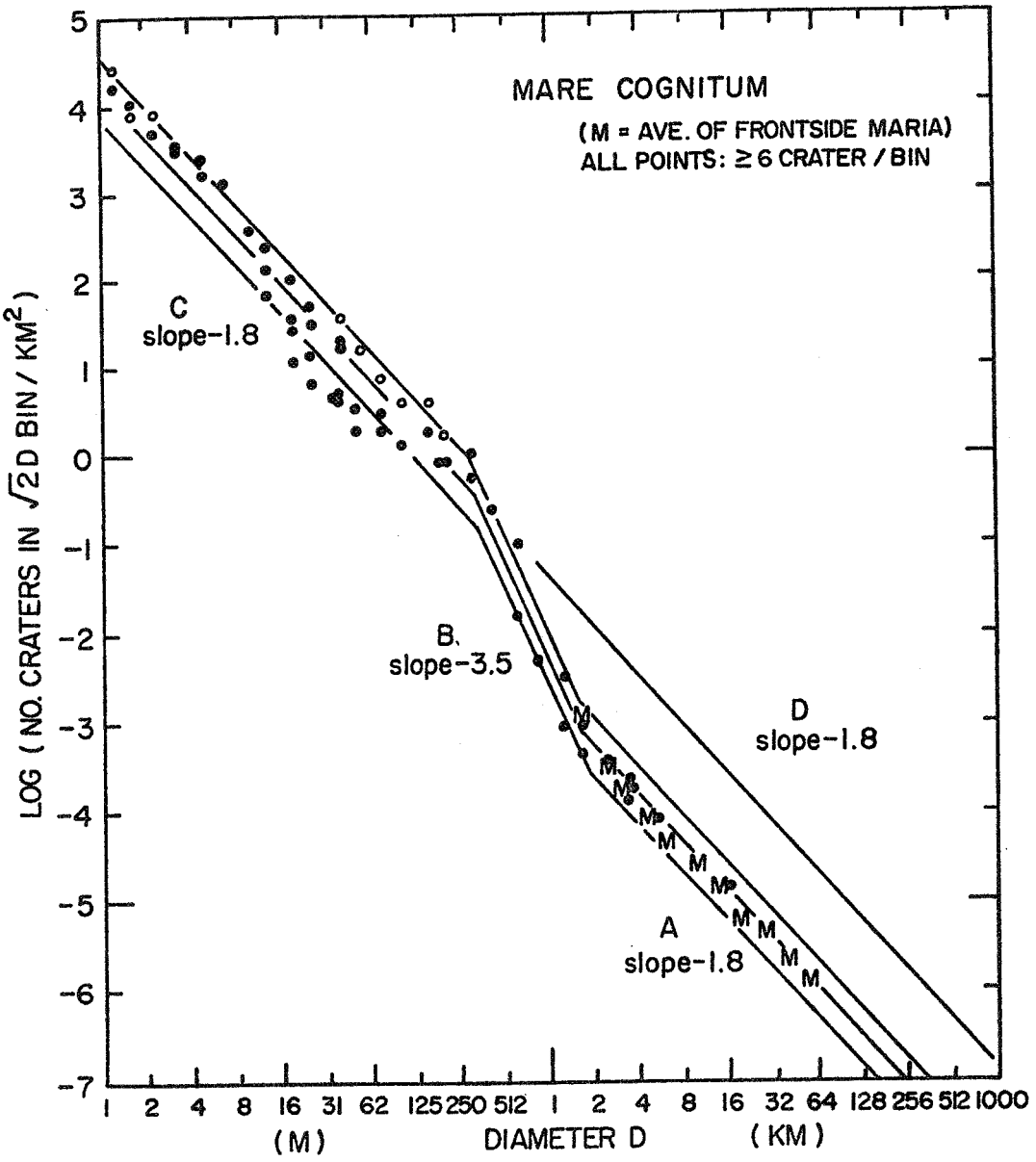

Figure 1: Crater counts in Mare Cognitum. Segment C offers evidence for saturation equilibrium as discussed in text.