N94-1

CONFIRMATION OF SATURATION EQUILIBRIUM CONDITIONS IN CRATER POPULATIONS;

William K. Hartmann, PSI, Tucson AZ 85719, Robert W. Gaskell, JPL, Cal Tech, Pasadena CA 091009

We have continued work on realistic numerical models of cratered surfaces, as first reported at last year's LPSC. We confirm the saturation equilibrium level with a new, independent test.

One of us (RWG) has developed a realistic computer simulation of a cratered surface. The model starts with a smooth surface or fractal topography, and adds primary craters according to the cumulative (or log-incremental) power law with exponent -1.83, as observed on lunar maria and martian plains. Each crater has an ejecta blanket with the volume of the crater, feathering out to a distance of 4 crater radii.

We use the model to test the levels of saturation equilibrium reached in naturally occurring systems, by increasing crater density and observing its dependence on various parameters. In particular we have tested to see if these artificial systems reach the level found by Hartmann [1] on heavily cratered planetary surfaces, hypothesized to be the natural saturation equilibrium level. (On the plot of relative crater densities, Figure 1, this is the horizontal line referred to as $N/N_{HC} = 1$.)

Last year we reported that when we allowed input crater densities to rise to nearly 10 times that level, the observed numbers of craters stabilizes near the level $N/N_{HC} = 1$, supporting the hypothesis that this is the saturation level [2, 3].

These tests are important because the Voyager team predicated its interpretation of all outer planet satellites on the assumption that saturation equilibrium has never been achieved, and thus that all impacts that ever occurred are recorded in the crater diameter distribution. This appears to be incorrect, in which case the interpretations change significantly [2].

This year's work gives the first results of a crater population that includes secondaries. Our model "Gaskell-4" (September, 1992) includes primaries as described above, but also includes a secondary population, defined by exponent -4. We allowed the largest secondary from each primary to be 0.10 times the size of the primary. These parameters will be changed to test their effects in future models (being run as this abstract is written).

The model gives realistic images of a cratered surface (Figure 1), although it appears richer in secondaries than real surfaces are. The effect of running the model toward saturation gives interesting results for the diameter distribution. Our most heavily cratered surface had the input number of primary craters reach about 0.65 times the hypothesized saturation equilibrium, but the input number rises to more than 100 times that level for secondaries below 1.4 km in size, i.e., $N/N_{HC} > 100$ (Figure 2).

In spite of the extremely high input crater densities among the secondaries, the observed crater densities cluster in the region $N/N_{HC} = 0.4$ to 2, the same range observed in the most heavily cratered terrains in the solar system. Among the primaries, the observed crater density averages about half the input density, implying that saturation is beginning, partly due to obliteration and suppression of large craters by the large numbers of small secondaries.

SATURATION OF CRATER MODELING, Hartmann, W.K. & Gaskell, R.W.

In conclusion, even with a very steep power law representing secondaries, it is hard to drive the observed size distribution more than a few times higher than $N/N_{HC} = 1$. This tends to confirm the earlier conclusions that natural saturation equilibrium sets in near $N/N_{HC} = 1$. The natural populations may show some structure above and below that line.
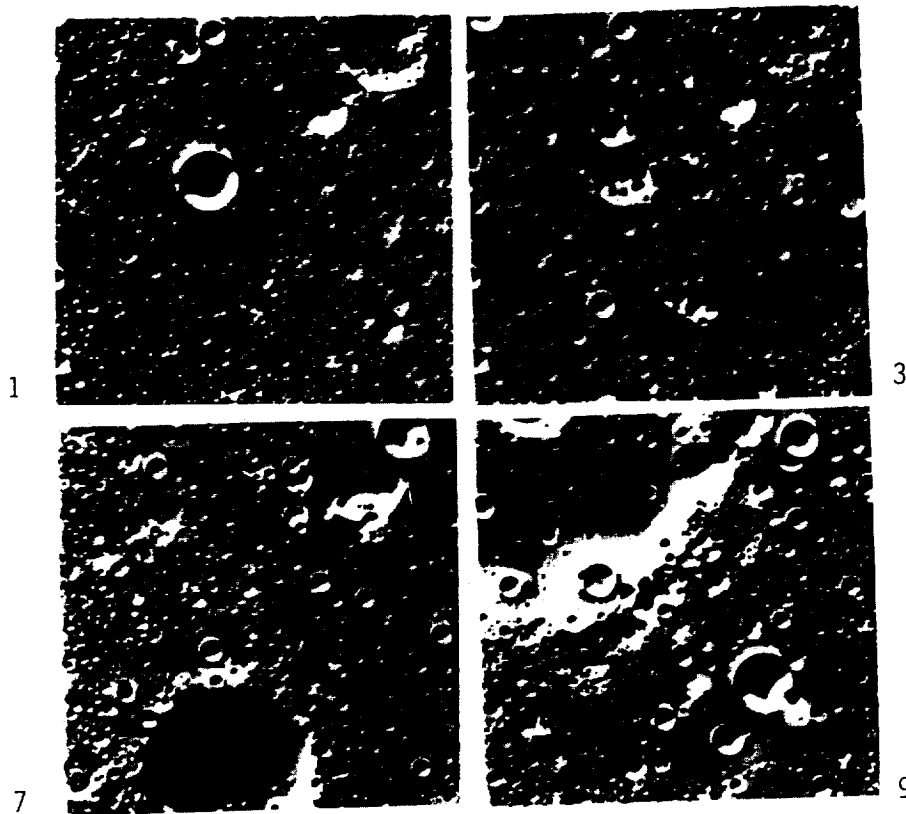

Figure 1.   Artificial cratered terrain created by Gaskell program, planet "Gaskell-04." Images are 522x522 km. They show 1st, 3rd, 7th and 9th stages of cratering in a 9-stage sequence.
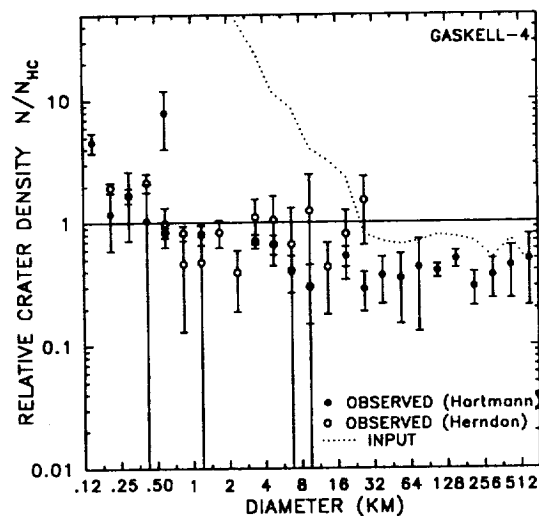

Figure 2. Relative diameter distribution observed on Gaskell-4" surface. Points with error bars are observed. Dotted line gives input number density of craters.

REFERENCES

[1] Hartmann, W.K. 1984. *Icarus* **60**, 56-74.
[2] Hartmann, W.K. 1992. *LPSC XXIII Abstracts*.
[3] Hartmann, W.K., and Gaskell, R.W. 1992. *LPSC XXIII Abstracts*.