ON THE QUESTION OF CRATERING EQUILIBRIUM VS. PRODUCTION POPULATIONS, G. Neukum (DFVLR, Institute for Optoelectronics, Planetary Remote Sensing Section, 8031 Wessling, W. Germany)

1. Introduction. There has been a long scientific debate in the field of impact cratering studies about the highest crater frequencies on the most ancient surface parts of the terrestrial planets and the moons of Jupiter and Saturn: what is the nature of those crater populations, are they in cratering equilibrium or in a state of production? There are essentially two schools of science presently: those who believe these crater populations reflect a state of equilibrium and those who deny this. school is the older one, the idea brought up by Hartmann (1,2,3) and to some extent by Shoemaker (4). Strom and Woronow (5,6) and Neukum (7,8,9) have contradicted this view on the basis of new and better data. There is a recent attempt by Hartmann (10), however, to prove his hypothesis of "saturation equilibrium".

2. Data. Recent crater counts by (5,6,7,8,9) show that the crater size distributions on the terrestrial planets and the moons of Jupiter and Saturn do not follow simple power laws but that they are complex functions which can be fitted by polynomials up to 11th degree (9).

Cumulative crater frequency data (13) for different lunar stratigraphic units are presented in Fig. 1. Those distributions with varying distribution indexes (exponents) will never and obviously do not approach such states of equilibrium (or "saturation equilibrium" as Hartmann (10) calls it) with $D^{-1.8}$ or D^{-2} characteristics (11,12,14).

The shapes of the distributions are largely preserved independent of age (i. e. absolute density). The different relative frequencies reflect different ages according to the stratigraphic relationships (from young to old: Copernican/ Eratosthenian, Imbrian, Nectarian, Pre-Nectarian).

The crater frequency for the lunar and the martian highlands is in detail given in Fig. 2 in form of relative crater frequency in comparison with Hartmanns $D^{-1.8}$ "saturation equilibrium" line. There is nothing like a behavior following a $D^{-1.8}$ or D^{-2} law as Hartmann (10) postulates for those data. The same behavior has been found by Strom and Woronow (5).

Comparing with somewhat younger lunar areas (e. g. Imbrian or Nectarian aged), a production distribution can also be measured at smaller sizes. The resulting distribution (combined with the data at $D > 20$ km as in Fig. 1) in form of relative crater frequency is given in Fig. 3 (solid line) in comparison with the data from the most heavily cratered lunar highlands. It appears that both distributions are roughly equal, the highland data showing some deficiency of smaller ($D \lesssim 50$ km) craters. This deficiency can readily be explained by preferential destruction of part of those craters through superposition and intercrater highland volcanism. Thus, the smaller-crater part of the highland distributions in Fig. 2 and 3 is interpreted to be not quite in production but still showing the basic production distribution features even in the size range $D < 50$ km as expected from theory for cumulative distribution indexes < -2 (12).

Fig. 4 gives a comparison of the lunar production size frequency curve (in terms of relative crater frequency for the highland case) with data (9) for Mercury and Ganymede (similar data exist for Callisto and for the moons of Saturn).

3. Conclusion. There is nothing like a common "saturation equilibrium" approached or achieved by the cratering processes on the terrestrial planets and the moons of Jupiter and Saturn. Even the distributions on the most heavily cratered surfaces are sufficiently unaffected by destruction effects for sizes D $\gtrsim$ 20 km and yield approximate production distributions. These findings are in accordance with former interpretations by Strom and Woronow (5,6) and Neukum (7,8,9). Hartmann's view (10) of "saturation equilibrium" is not supported by any of our data.

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