LUNAR ROCK EROSION. E. Schneider, Lunar Science Institute, Houston, TX 77058 (permanent address: Max Planck Institut für Kernphysik, Heidelberg, Germany) and F. Hörz, NASA-Johnson Space Center, Houston, TX 77058.

Two basic processes caused by the bombardment of micrometeoroids contribute to the destruction of lunar rocks i.e., "catastrophic breakup: and "particle abrasion" (1). The latter process was simulated in the present study via Monte Carlo computer techniques in order to assess the gradual mass wasting of lunar rocks.

INPUT DATA: Measured microcrater size frequency distributions from rocks 12054 and 60015 for craters 400-2500μm spall diameter (D) and an extrapolated microcrater production slope of $N_D=CD^{-3}$ for all larger craters yielded the probability of occurrence for specific crater sizes. The crater volumina (V_C) were calculated using Gault's (1973) experimental data. From these volumina the crater depth (d_C) was derived via the simple relationship $d_C=V_C/\pi(\frac{D}{2})^2$. The test surface was a grid consisting of 175x175 "cells" of fixed x/y coordinates ($x_{1...175}/Y_{1...175}$) and of 400μm sidelength each, thus resulting in a total test area of 49cm². However, only a central square of 25cm² was analyzed in order to eliminate "edge-effects" at the boundary of the test surface. The crater size intervals were chosen such that the surface area of the associated average crater (C_a) was an integer number of "cells" (Z), i.e., $C_a=uZ$; for the smallest crater u=1; for the largest crater u=1965.

COMPUTER RUN: Using the above input data, three random number generators determined the X/Y coordinates of the impact point and the crater size produced. The entire output was purposely expressed only in terms of total number of craters produced. Thus the raw data are independent of the actual flux of micrometeoroids and model elapsed times may easily be defined based on best estimates of the flux of micrometeoroids. Figs. 1 through 4 illustrate some representative results.

Fig. 1: Typical cross-sections spaced 4mm apart (Y_{76}, Y_{86}, Y_{96}) after 10,000, 50,000 and 100,000 craters produced. Vertical exaggeration: 17.6 times; (white: material removed; hatched: remaining rock).

Fig. 2: Average depth eroded of entire test surface (25cm²). Notice the significant effects of a few, though big craters, e.g., between 30,000 and 40,000 or between 90,000 and 100,000 craters.

Fig. 3: Total number of craters produced versus % of surface area affected by at least one impact. Notice that already after only 10,000 craters more than 50% of the total surface has undergone erosion. It takes another 90,000 craters to completely remove the remaining 50% surface area.

Fig. 4: Attempt to assess the "representative" nature or lack thereof of various sized surface areas. Typically used in the study of lunar surface processes. The computer iterated over the entire 25cm² test area and searched for the least (=shallowest) and most (=deepest) eroded unit area (=5,2,1, .64 and .16cm²). These "extremes" in erosional state are compared to the "average" of the entire area. The deviation from the average-expressed in percent-is a direct measure how typical or atypical small lunar rock chips may be with respect to their parent rock.

FLUX DEPENDENT IMPLICATIONS: The above program simulated the effects of microcraters 152 to 24,000μm in spall diameter. Corresponding micrometeoroid

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flux estimates were summarized by (3). Hartung et al. (this volume) and others point out that the average flux for the past few 10^6 years may have been significantly lower than the flux during the past 10^4 years and especially compared to present-day micrometeoroid fluxes based on satellites. However, in analogy to rock 68815 (4) and other samples associated with S-Ray crater, an exposure age of $2x10^6$ may be inferred for rock 68415. Thus a minimum crater production rate of 1.1 crater/cm^2/10^6 years (larger than 2000µm spall diameter) can be derived; the present day satellite data yield a production rate of 50 craters/cm^2/10^6 years.

Erosion-rates and crater saturation times based on a variety of fluxes are summarized in Table 1. Erosion rates determined elsewhere (5,6) lead to a best crater production rate of 5-10 events >2000µm spall diameter per m.y. averaged over the last few 10^6 years. Using these rates it can be seen that surface exposure times of individual rocks based on microcrater frequencies are not valid for exposure times in excess of $3x10^6$ years and highly questionable for $1-3x10^6$ years (7,8).

CRATER PRODUCTION		ROCK 68415	MODEL FLUXES			PRESENT SATELLITE FLUX
RATE: $\Sigma N_{>2000}/cm^2$ m.y.		1.1	5	10	20	50
MODEL ELAPSED TIME FOR ENTIRE COMPUTER RUN (=100,000 craters) IN YEARS		$27.9x10^6$	$6.19x10^6$	$3.07x10^6$	$1.55x10^6$	$6.14x10^5$
EROSION RATE (see Fig. 2) mm/10^6 year		.072	.323	.651	1.290	2.120
CRATER	I	$3.3x10^6$	$7.2x10^5$	$3.6x10^5$	$1.8x10^5$	$7.2x10^4$
SATURATION	II	$9.3x10^6$	$2.1x10^6$	$1.0x10^6$	$5.1x10^5$	$2.1x10^5$
TIMES	III	$16.0x10^6$	$3.6x10^6$	$1.8x10^6$	$9.0x10^5$	$3.6x10^5$
(years)$^{(x)}$	IV	$8.4x10^6$	$1.9x10^6$	$9.2x10^5$	$4.6x10^5$	$1.8x10^5$

$^{(x)}$I. Neukum, 1973 [areal density=.15;$\hat{=}$3.6 craters$_{>2000}$/cm^2] (7)

II. Morrison et al., 1973 [limiting frequency value$\hat{=}$10.2 craters$_{>2000}$/cm^2] (8)

III. Hartung et al., 1973 [equillibration value$\hat{=}$18 craters$_{>2000}$/cm^2] (9)

IV. This model [90% of total rock surface destroyed;$\hat{=}$9.2 craters$_{>2000}$/cm^2]

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Fig. 1

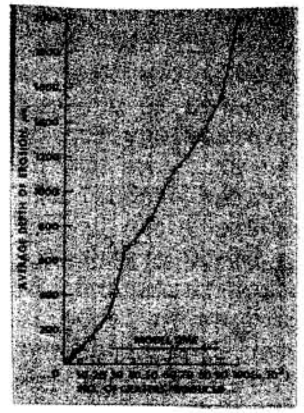

Fig. 2

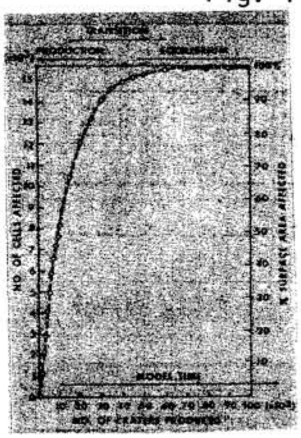

Fig. 3

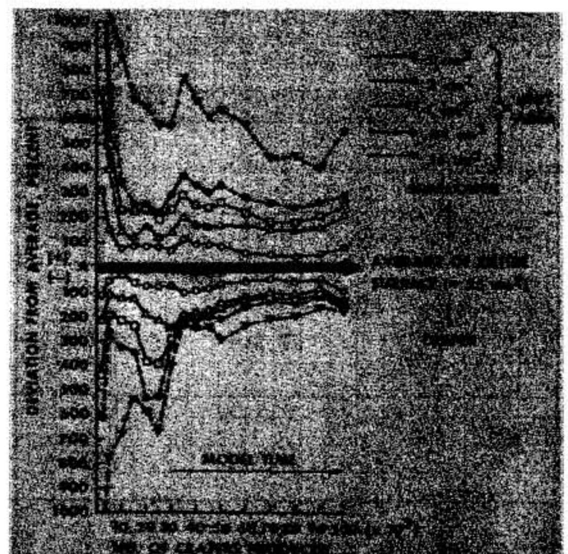

Fig. 4

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