MICROCRATER STUDIES, DERIVED METEOROID FLUXES AND COMPARISON WITH SATELLITE-BORNE EXPERIMENTS

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Lunar Microcraters

A special study of microcraters on sample 60015,35 was made (fig. 1). Pit diameters were measured optically down to 17 microns. A rough coating of accretionary material prevented scanning electron microscope observation of pits less than 10 microns in diameter. However, micron-sized pits were counted on 0.5 mm^2 of the smooth surfaces of larger, 100-micron-diameter glass-lined pits. These data combined with earlier results for 60015(1) yield a size distribution over the pit diameter range from 1 to 500 microns (fig. 2).

The solar flare track exposure age of 60015 was found to be 10^5 years, based on a revised track production rate. Complete microcrater spall zones were easily observable on 60015. The spall-to-pit-diameter ratio averaged about 4 for 70 microcraters with pits between 45 and 380 microns in diameter. The coating of 60015 was initially glass a few mm thick but has devitrified to elongate plagioclase crystals with 2-to 50-micron dimensions, and pyroxene-composition interstitial material. Point electron microprobe analysis for Fe, Mg, Ca, Al, and Si of glasses lining several 100-micron-sized pits shows no indication of material in the pit glasses that is outside the range in composition of the host sample phases. Either the projectile material composition is similar to the host material composition or little or no projectile material remained in the pit glass.

Craters counted and measured on samples 69935,18; 60315,29; 63503,17; 70215,34; 74275,36; and 79155,19 yield size distributions (fig. 3) similar to those reported previously (2). Minimum exposure ages for these samples, based on mm-sized microcrater counts, range between 10^5 and 10^6 years.

Laboratory Simulation Experiments

Using an electrostatic dust accelerator projectiles in the mass range between 10^{-10} and 10^{-16}g were accelerated to velocities between 1 and 30 km/sec. Using a lithium plasma gun projectile masses between 10^{-5} and 10^{-8}g were accelerated to velocities between 2,5 and 18 km/sec. Projectile materials were aluminium, carbon, iron and glass, and target materials were glass, norite, stainless steel, aluminium and copper (3).

A primary result is that for normal impacts, through the whole velocity range, the ratio of the spallation zone diameter to projectile diameter, D_s/d, is proportional to the 2/3 power of the impact velocity, thus $D_s/d \sim v^{2/3}$. For the electrostatic accelerator experiments the ratio of the microcrater pit diameter to projectile is also proportional to the 2/3 power of the impact velo-

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city, thus $D_p/d \sim v^{2/3}$ (fig. 4). Plasma gun experiments, however, produced mainly pitless craters. The ratio D_s/d, seems to increase slightly with increasing mass. From experiments showing pits, D_s/d increased a factor of 2 as projectile mass increased from 10^{-12}g to 10^{-6}g. The results are almost independent from the projectile material but depend strongly on the target material or target strength. The impact kinetic energy, E, is proportional to the crater Volume, V (fig. 4). Using a formula from Gault (4), valid for mm-to-cm-sized projectiles, these results can be represented by changing slightly the constants:

$$D_s = 10^{-3.077} \rho_t^{-1/2} \rho_p^{+1/3} E^{1/2.65}$$

where ρ_t and ρ_p are target and projectile densities, respectively. Table 1 gives a comparison of measured and calculated values.

Meteoroid Fluxes

From each lunar sample with a known crater population and a known solar flare track exposure age (5,6,7) one may calculate the corresponding average interplanetary dust flux. From the results of the Pioneer 8/9 dust experiments (8) and from the results of the HEOS dust experiment (9) it is known that micrometeorite trajectories are extremely anisotropic due to different orbital characteristics for different-sized particles. The micron-sized component of dust approaches the earth-moon system from the apex direction (direction of earth's motion) at an average velocity of about 8 to 10 km/sec. Submicron-sized particles tend to approach from the direction of the sun at velocities greater than 50 km/sec. Using these numbers the cumulative flux -vs- mass curves for these samples were calculated and are shown as a broad band in figure 5 together with results from satellite-borne experiments.

Fluxes from satellite-borne experiments are only about 1 order of magnitude higher than those from lunar data. This difference may be due to incorrect earlier assumptions of an isotropic flux and a 2π-exposure geometry or to an increasing meteoroid flux with time.

Table 1:

Energy (erg)	D_s measured (um)	D_s calculated
$4 \cdot 10^4$	450 ± 20	400
$1.1 \cdot 10^4$	300 ∓ 20	250
$84.7 \cdot 10^4$	1200 ± 100	1250
$43.4 \cdot 10^4$	1000 ± 100	980
$24.3 \cdot 10^4$	700 ± 50	780
17.6	19 ± 2	22
3	9 ± 2	11

(1) G. Neukum et al. (1973) Proc. 4th Lunar Sci. Conf., 3, 3255-3276;(2) F.Hörz et al. (1971) Journ. Geo.Res.,76, 5770-5798; (3) K. Nagel (1973) Diplomarbeit, Universität Heidelberg; (4) D.E. Gault (1973) The Moon, 6, 32-44; (5) E. Schneider et al (1973), Proc. 4th Lunar Sci. Conf., 3, 3277-3290; (6) G. Neukum (to be published); (7) J.B. Hartung et al. (1972) Proc. 3rd Lunar Sci. Conf., 3, 2735-2753; (8) O.E. Berg and E. Grün (1973) Space Res. XIII, 1047; H.J. Hoffmann et al. (1974) Planet. Space Sci. (in press)

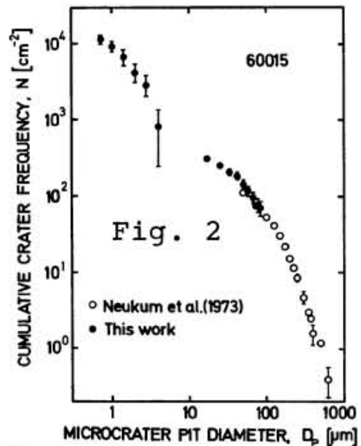

Fig. 2

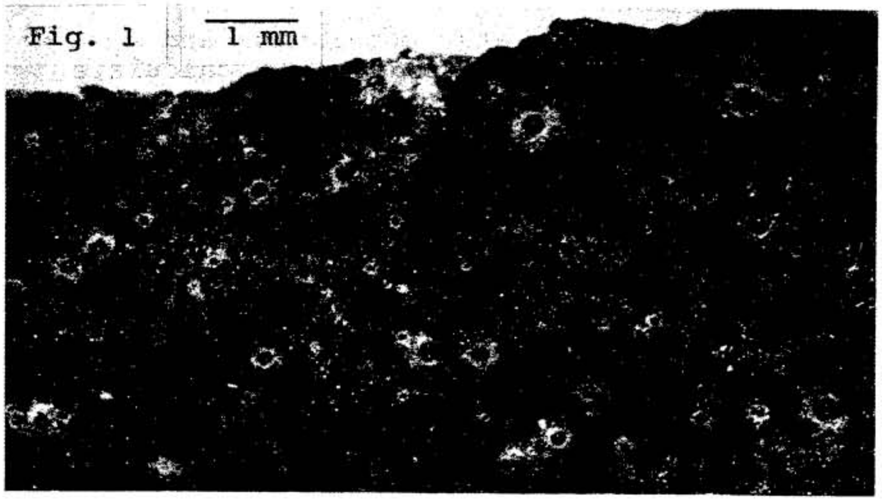

Fig. 1

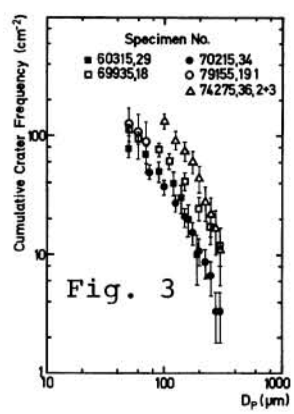

Fig. 3

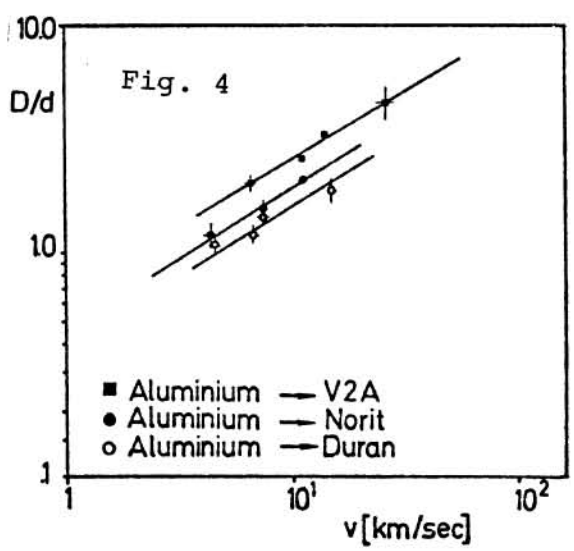

Fig. 4

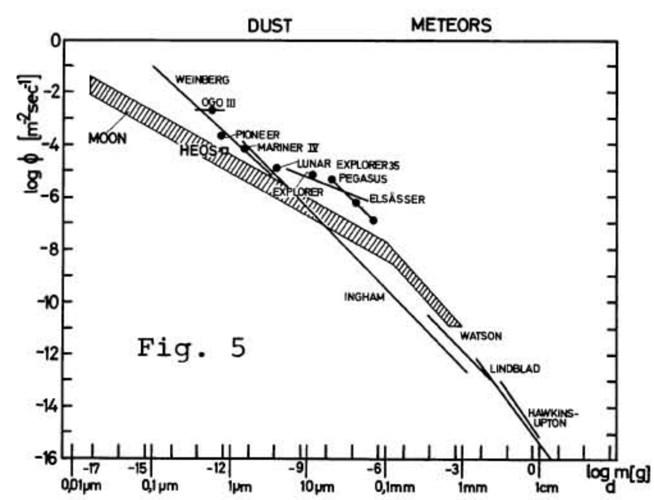

Fig. 5