

DENSITY, CHEMISTRY AND SIZE DISTRIBUTION OF INTERPLANETARY DUST.
 D.E. Brownlee¹, F. Horz², J.B. Hartung³, D.E. Gault⁴, (1) Dept. of Astronomy,
 Univ. of Washington, Seattle, WA 98195, (2) Geology Branch Johnson Space
 Center, Houston, TX 77058, (3) Dept. of Earth and Space Sci., SUNY, Stony
 Brook, NY 11790, (4) NASA Ames Research Center, Moffett Field, CA 94035.

Density

In previous work¹ it was shown that depth/diameters ratios of micro-craters in lunar glass could be used to infer mean densities of interplanetary dust. Previous and recent measurements of craters in the 0.2 μ m to 100 μ m size range on the glass surfaces of 60095, 15286, 67115, and a Luna 16 spherule show a range of depth diameter (P/Dp) ratios from 0.25 to 1.2. Here depth P is defined as the maximum depth below the original surface plane and the diameter Dp is the mean pit diameter measured at the plane of the original surface. There is a spread in P/Dp values but the majority of the measured values fall between 0.5 and 0.8. For impact velocities of 5-20 km s⁻¹ laboratory calibrations² indicate that these P/Dp values correspond to typical projectile densities of 2-4 g cm⁻³. The measured P/Dp values do not rule out the possible existence of a minor fraction <10% of particles as dense as metallic iron. The P/Dp values do however rule out the possibility of more than a miniscule fraction of micron-sized particles having densities < 1 g cm⁻³. Spacecraft measurements reported by Fechtig *et al.*³ indicate that microparticles >1 μ m have average lunar impact velocities of 10 km s⁻¹. This impact velocity is within the range simulated in the laboratory calibrations² and we believe that the conclusions on particle density for particles between 1 μ m and 50 μ m are very reliable.

Smith *et al.*⁴ measured P/Dp values for 1.5 μ m to 7 μ m diameter craters on 300 μ m diameter Apollo 15 glass spheres. They report 3 groupings of P/Dp corresponding to projectile densities of 8 g cm⁻³, 3 g cm⁻³ and 1-2 g cm⁻³. Their results agree with ours in that they do not see evidence for densities <1 g cm⁻³. There is disagreement however in that they report three distinct density groups including a significant fraction of particles as dense as metallic iron. In fact they imply that most of the 1 μ m meteoroids should be metallic iron. None of the 4 surfaces we have studied show crater P/Dp distributions like the Smith *et al.* data. We have looked at a large number of craters made by 1 μ m particles and see no evidence that more than 10% of the particles could be as dense as metallic iron.

Chemistry

We did detailed microprobe searches for meteoritic enrichment in the glass pit linings of 2 mm-sized craters and a 100 μ m crater in pure lunar feldspars. The craters were sectioned parallel to the crater symmetry axes. Enrichments of Fe, Mg and Ni in the glass pit lining were looked for by defocused beam analysis of a large number of spots on the glass and on the

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underlying unmelted matrix. The two larger craters showed a Fe, Mg enrichment in the pit lining. In the most positive case, however, the enrichment is consistent with only 0.1% chondritic material mixed into the glass crater lining. These results imply that following the impact of typical 10^{-6} g meteoroids onto a silicate target, nearly 100% of the meteoroid is vaporized or otherwise ejected from the impact site.

Size Distribution

A size frequency distribution for crater sizes from 800Å to 60µm was determined on a smooth fracture surface of the 3 cm glass sphere 60095. Analysis of a fracture surface eliminates possible problems of pseudo craters which could conceivably be formed on original glass sphere surfaces during the sphere forming process. A total of 157 craters were counted from SEM mosaics taken at nine different magnifications. The data plotted as log cumulative crater density vs. long crater diameter can be approximately fit by a piecewise linear curve of slope -1 to -1.5 for craters $>2\mu$ and a slope of -2.5 for sizes $<2\mu$. This result is in good agreement with the averaged lunar microcrater size-frequency curve derived by Fechtig *et al.*³. The 60095 cumulative crater density at 0.1µm is 2×10^6 craters cm^{-2} and there is no evidence for a small size turnover. The high density and steep slope in the submicron region is in good agreement with crater counts reported by Blanford *et al.*⁵ but does not agree with previous work we did on the glass sample 15286. The 15286 sample has a normal population of craters $>1\mu\text{m}$ but does not have a steep slope below 1µm. Reexamination of 15286 shows that not only does it not have many submicron craters but that it does not have many submicron micro-accretionary particles of the type described by Blanford *et al.*⁵. Micro-accretionary features are expected on all surfaces exposed at the lunar surface. That 15286 appears deficient in submicron accretionary features implies that submicron features have been obscured. The crater data for craters $\geq 1\mu\text{m}$ on 15286 are perfectly valid but previously published data for the submicron craters are unreliable because of the obscuration effects. The obscuration was most probably caused by either etching or the condensation of a thin film. The 15286 surface was one of the few lunar samples with a flat crater size distribution below 1µm. It now appears probable that all microcrater size frequency plots which truly reflect the size distribution of submicron micro-meteorites have steep slopes on the order of -2 or slightly steeper.

References

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