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BLOCK DISTRIBUTIONS ON THE LUNAR SURFACE: A COMPARISON BETWEEN MEASUREMENTS OBTAINED FROM SURFACE AND ORBITAL PHOTOGRAPHY; Mark J. Cintala+ and Kathleen M. McBride◇ +Code SN4, NASA Johnson Space Center; ◇Code C23, Lockheed Engineering and Science Co.; both in Houston, TX 77058.

The distribution of blocks on the lunar surface is an important parameter not only in the interpretation of remote-sensing data such as those obtained from radar[1] and thermal[2] sensors, but also in operational activities, such as hazard evaluation for landing spacecraft and trafficability assessment for traverse planning. Unfortunately, few data exist that treat the distribution of blocky debris on the lunar surface. Those distributions that do exist either cover limited areas around landed spacecraft,[3,4] treat relatively small fragments,[3,4,5,6] or address "pathological" cases, such as distributions around impact craters.[7,8] The ideal situation would permit assessment of block distributions over a wide area and a large range of sizes. This contribution resulted from an evaluation of the usefulness of high-resolution orbital photography in deriving the distribution of blocks on the lunar surface by comparing such data with those obtained from Surveyor photography of the same localities on the Moon.

Methodology: Enlargements of Lunar-Orbiter photography were used in conjunction with a digitizing tablet to collect the locations and dimensions of blocks surrounding the Surveyor 1, 3, 6, and 7 landing sites. Data were reduced to the location (latitude and longitude) and the major axis of the visible portion of each block;[9] shadows sometimes made it difficult to assess whether the visible major axis corresponded with the actual principal dimension. These data were then correlated with the locations of major craters in the study areas, thus subdividing the data set into blocks obviously associated with craters and those in intercrater areas. A block was arbitrarily defined to be associated with a crater when its location was within 1.1 crater radii of the crater's center. Since this study was commissioned for the ultimate purpose of determining hazards to landing spacecraft, such a definition was deemed appropriate in defining block-related hazards associated with craters. Size distributions of smaller fragments as determined from Surveyor photography were obtained as measurements from the graphical data of [3]. Basic comparisons were performed through use of cumulative-frequency distributions identical to those applied to studies of crater-count data.

Data: The Surveyor data and least-squares fits passed through them are presented in Figure 1, along with the block distributions for the four areas as derived from the orbital photography. Three separate distributions are plotted for all but the Surveyor 7 site: one each for the blocks inside craters, those in the intercrater areas, and the sum of both subsets. The nature of the Surveyor 7 site, located on the near-field ejecta deposits of Tycho, precludes such a subdivision. In all cases, the slopes of the distributions determined from the orbital photography are greater than those obtained from the Surveyor photography, but there is a trend in the Surveyor 1 and 3 data toward lower slopes at the smaller size ranges. Only the number of large blocks at the Surveyor 3 site appear to be in agreement with the projected trend of the smaller fragments, although this agreement could be fortuitous, in light of the substantial differences in slopes. The densities of large blocks are overestimated by the distributions of smaller fragments at the other three sites.

Discussion: The reasons for the differences between the orbital and surface data are not clear. The nonlinear distributions for the three mare sites (Surveyors 1, 3, and 6) provide potential for partial reconciliation between the two, in that their slopes for the smaller sizes appear to be within the 95% uncertainty limits on the Surveyor fits. This decrease in slope, however, could be an artifact of deteriorating discriminability as the limit of resolution is approached. The Surveyor 7 data clearly deviate from the distribution of large blocks, and it is difficult to envision an effect related to resolution that could account for such a well-defined difference. Even given these uncertainties, it is clear that extrapolation of data obtained from surface photography has the potential to overestimate the density of larger blocks on the lunar surface, at least at the four sites studied here. Conversely, simple extrapolation of areal densities of large blocks cannot be justified in predicting the distribution of smaller fragments on the lunar surface.

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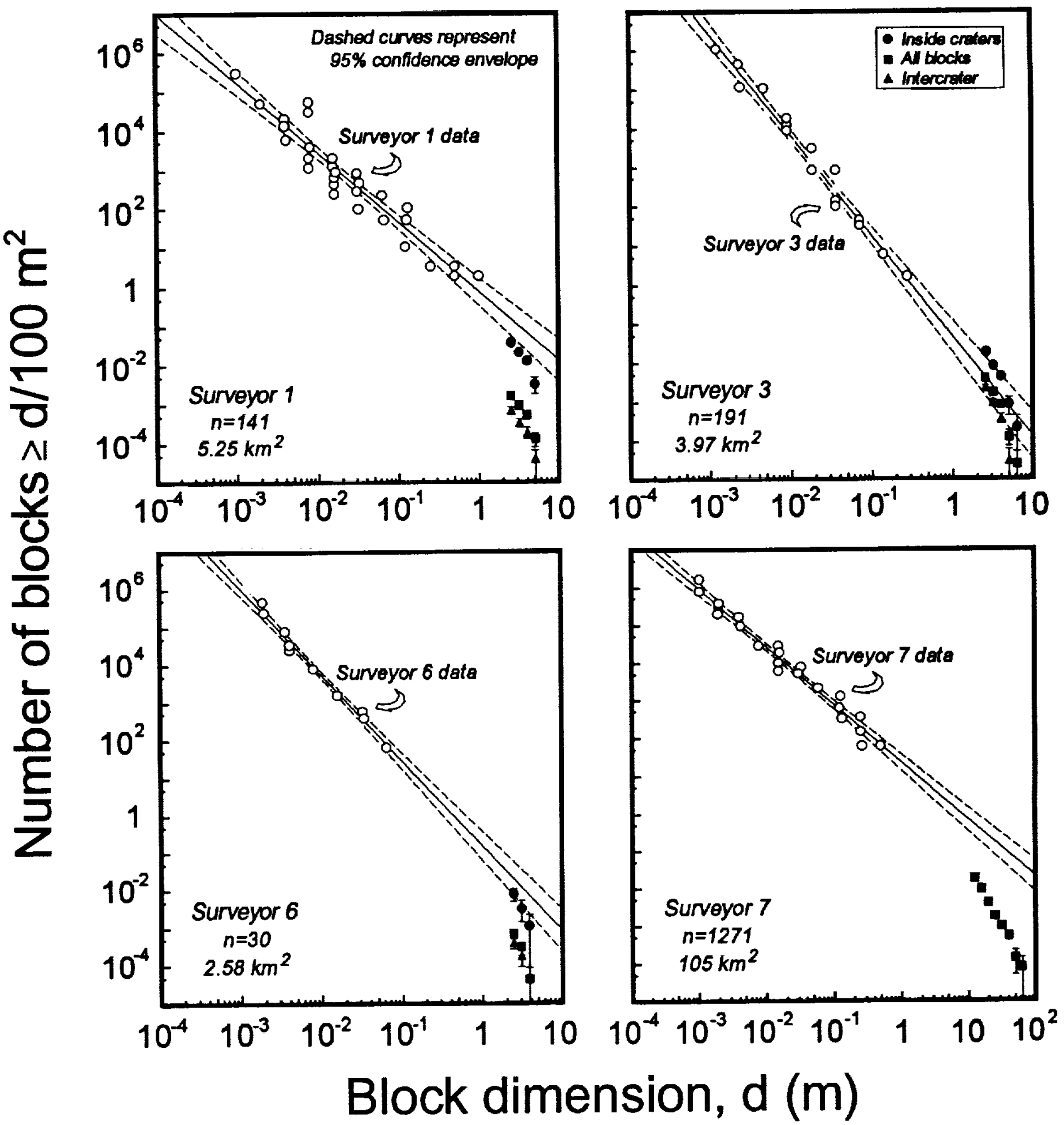

Figure 1. Block distributions as measured in the vicinity of the Surveyor 1, 3, 6, and 7 spacecraft. Only those blocks whose dimensions are larger than the effective resolution limit of the respective photograph are included in the plots. The number of blocks in each sample is indicated, as is the area on the lunar surface covered by each set of measurements. Note that the large blocks follow distributions that are invariably steeper than those of the smaller fragments measured on the Surveyor photographs.[3] Error bars represent 1-σ confidence limits, assuming that the data can be represented by Poisson distributions.[10]

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