

REFINEMENT OF THE LUNAR PRODUCTION FUNCTION – INVESTIGATION OF THE CSFD-SLOPE ON EJECTA BLANKETS. A. Oetting, H. Hiesinger, C. H. van der Bogert, Westfälische Wilhelms-Universität Münster, Institut für Planetologie, Wilhelm-Klemm-Str. 10, 48149 Münster, Germany (aoetting@uni-muenster.de)

Introduction: The dating of geological surfaces on the Moon is crucial for understanding its geological history and evolution. Crater size-frequency distribution (CSFD) measurements can be used for determining both the relative and absolute ages of surfaces, where older surfaces reflect more and larger craters than younger surfaces [1-4]. The first step for determining relative surface ages involves the construction of a production functions (PFs), which reflects the size-frequency distribution of craters forming on the Moon. When a CSFD is fit with such a PF, then its relative y-position reflects the relative age of the surface. A frequently used PF was empirically-derived by measuring craters on reference surfaces using Apollo era data (Neukum, 1983 [1]), which was revised in 2001 [5], and is valid for crater diameters of 10 m - 300 km and 10 m - 100 km, respectively.

With the increased image resolution of more recent missions [e.g., 6], it has been possible to measure CSFDs for crater diameters down to a few meters. Thus, it would be useful to be able to extend the PF to smaller diameters to allow the fitting of relative and absolute ages for young/small geological units. We aim to perform a further refinement of the PF for small crater diameters.

Target properties are especially relevant for small craters formed in the strength regime, which was investigated in several studies [e.g., 7, 8, 9]. The study of [7] at Jackson crater indicates that the crater diameter is 20% larger in the ejecta material than in the melt pool material. Therefore, we aim to conduct the crater counts only on continuous ejecta deposits so that they are comparable to measurements done on ejecta deposits at larger crater diameters.

Another influence on the CSFD slope are secondary craters [e.g., 10-12]. Secondary craters can con-

taminate the count area, so that more craters are present than just the primary craters that should be counted, resulting in a steeper CSFD slope [e.g., 10, 13, 14]. To avoid this effect and obtain the cleanest PF possible, we selected ejecta areas derived from young Copernican-aged craters. This minimized the number of field secondary craters on the ejecta and avoided major degradation of the small craters [15, 16]. However, the identification of self-secondary craters remains problematic, since they occur irregularly distributed on the ejecta blankets and have morphologies similar to primary craters [e.g., 12, 13].

Currently, we focused on Giordano Bruno (GB) and Moore F, as well as counts by Hiesinger et al. 2012 [17] done on North Ray. In the next steps, we plan to extend our counts to similar young craters.

Method: We used Lunar Reconnaissance Orbiter Narrow Angle Camera (NAC) images, including M180509194LE, M1122929850LE and M103831840LE/RE with resolutions between 1.14 m/px and 1.6 m/px and incidence angles between 58° and 78° for GB. For Moore F, counts were conducted on M1107052575RE and M1112971104RE with resolutions of about 1.5 m/px and incidence angles between 62° and 65°. The counts at North Ray of [17] were done on the image M129187331LE/RE with incidence of 54° and resolution ~0.5 m/px. The counting areas are shown in Figure 1. The CSFDs were measured in ArcGIS with the CraterTools add-in of [18] and displayed in CraterStats with pseudo-log binning [19].

Three ejecta areas were investigated at GB, two at Moore F, and four at North Ray. The selected counting areas were aimed to be representative for the crater of interest and are visually free of resurfacing events such as secondary crater clusters and rays.

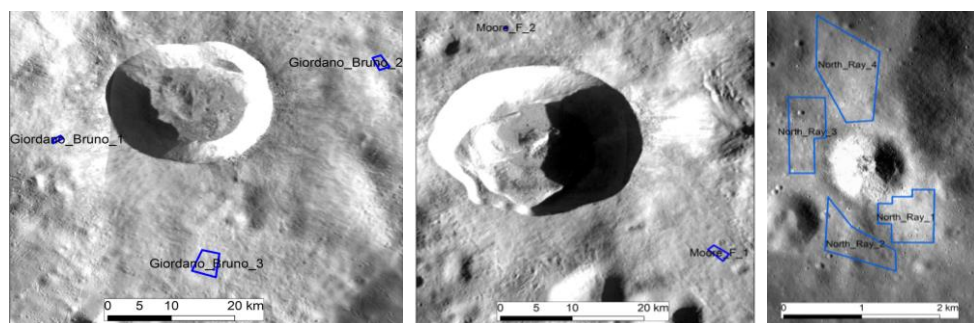


Fig.1: Areas on GB (left), Moore F (middle) and North Ray (right) on which the CSFD were determined.

Results: The comparison between the individual CSFD slopes at GB, Moore F and North Ray all show slightly steeper slopes than the nominal -3 slope of [1] for crater diameters between 10 m and <1 km. Similar to [17] we combined the statistics from the separate count areas into one file and display these CSFDs in a cumulative plot in Figure 2. The overall steepness is about -3.6 at GB, -3.06 at Moore F, and -3.09 at North Ray. The roll over and the largest bin(s) were excluded, as they do not provide reliable values for the calculation. Considering only the slope for craters with a diameter of less than 10 m, we get slopes of -3.77 at GB, -2.82 at Moore F and -2.64 at North Ray.

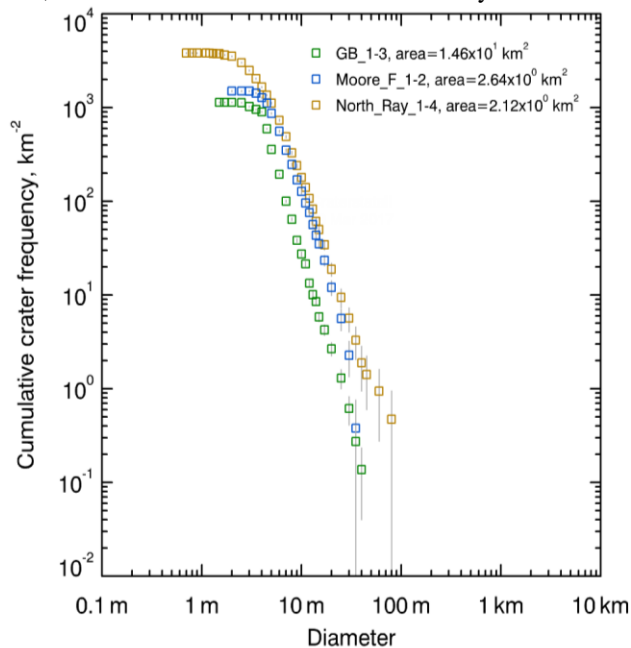


Fig. 2: Display of the combined CSFD at GB (green), Moore F (blue) and North Ray (orange), respectively. The vertical lines of individual data points represent the error bars.

Discussion: We found that the overall slope of these counting areas vary only marginally from Neukum's [1] -3 slope, except at GB. A reason for our steeper slopes might be possible contaminations by secondaries, particularly self-secondaries [e.g., 10, 13, 17]. However, the areas were selected carefully and secondary clusters and rays were excluded. Despite this, random secondaries, which couldn't be identified based on their morphology, may have been unintentionally included. As described, for example in [12], there is a high variability of crater densities across ejecta blankets, which may result from self-secondary craters. These as well cannot be easily separated from primary craters based on their morphological characteristics.

The CSFDs at Moore F and North Ray follow the slope of about -3. However, it is shown that the slope for craters smaller ~10 m is marginally shallower. This was also observed by [15] (and references therein) and [20] who investigated North Ray, Cone, Copernicus and Tycho craters. This might suggest that the CSFD of young Copernican craters has a slightly shallower slope at smaller crater diameters compared with larger diameters. Another explanation might be the faster degradation of small craters compared to larger craters. This effect was investigated in detail, for example by Mahanti et al. [21], who studied small lunar craters between 35 m and 250 m diameter. Crater walls of small crater are more affected by mass wasting processes, which may hinder their identification and thus fewer smaller craters would have been counted, resulting in a shallower CSFD slope. North Ray (52.3 Ma [20]), for instance, is influenced by the ejecta of the 8.3 km distant crater South Ray (2 Ma [22]). At Moore F, it is unclear which crater might have had an influence on the ejecta.

Whether this effect is due to a change in impactor flux or a result of the faster degradation of small craters, needs to be further investigated. Since we investigated craters only on the ejecta blanket of GB, Moore F and North Ray, we suspect that the differences in steepness of the slope are rather not be attributed to differences in target properties.

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