THE INFLUENCE OF TERRAIN PROPERTIES ON SMALL CRATER POPULATIONS ON THE MOON. J.-P. Williams, A. V. Pathare and E. S. Costello, Earth, Planetary and Space Sciences, University of California, Los Angeles, CA 90024, Planetary Science Institute, Tuscon, AZ 85715, Department of Geology and Geophysics, University of Hawai‘i at Mānoa, Honolulu, HI 96822, Hawaii Institute of Geophysics and Planetology, Honolulu, HI 96822.

Introduction: Crater counts conducted on the proximal ejecta of lunar craters have been found to yield inconsistencies in model ages, including craters used to anchor the crater chronology of the inner solar system (e.g. [1]). Studies using Lunar Reconnaissance Orbiter Camera (LROC) images have found evidence suggesting that self-secondary cratering (e.g. [2]) or variations in target properties (e.g. [3]) are contributing factors.

Past studies have found that craters superposed on the ejecta of crater Giordano Bruno (GB), a 22 km diameter Copernican-age crater, exhibit substantial variations in crater size-frequency distributions (CSFDs) [4,5,6,7]. Recent work by Plescia and Robinson [7] concluded that a significant fraction of the craters represented self-secondary craters. This is supported by the observation of partial burial of some craters by impact melt indicating the craters formed prior to the final emplacement of the melt [6].

Temperatures measured by LRO’s Diviner reveal substantial heterogeneity in thermophysical properties of GB’s ejecta [4,5]. Anisothermality in Diviner’s IR spectral passbands, indicative of surface rock fraction [8], have been found to correlate with the density of craters showing suppression of craters where rock fractions were higher [5] suggesting variations in terrain properties also likely play a role in the observed variations in CSFDs.

Because of GB’s young age (~few Ma [9]) and relatively pristine morphology, it provides a good opportunity to explore target effects and self-secondary cratering as the influence of these factors on CSFDs diminish over time. We expand on these earlier studies with systematic mapping of the crater population superposed on GB (Fig. 1) and correlation with Diviner-derived thermophysical properties (Figs. 2 – 4).

Observations: We have assembled an image mosaic of GB using LROC Narrow Angle Camera (NAC) images constrained to incidence angles 56° – 75° (optimal for identifying craters) with eastward-only illumination. This provides a high, sub-meter, resolution-controlled image base for conducting crater counts on the ejecta of GB. The crater populations are then compared with the nighttime fine-grained regolith temperatures and rock abundance derived from the Diviner channels 6 – 8 nighttime brightness temperatures [8].

Results and Discussion: Areas with higher rock abundance and higher nighttime regolith temperatures have fewer craters (i.e. lower crater point densities) (Fig. 3) with CSFDs that yield younger Absolute Model Ages (Fig. 4). Given that these high rock abundance surfaces contain high concentrations of blocks, it is possible that impacts into heterogeneous targets with boulders comparable in size to impactors may inhibit crater formation. This strongly supports the hypothesis that variations in terrain properties are partly responsible for the discrepancies in crater counts observed on the ejecta of GB. Since lunar chronology models rely on tying CSFDs to Cosmic-Ray Exposure ages of crater ejecta sampled by Apollo missions, understanding how variations in terrain properties can influence CSFDs is essential to the estimation of crater retention ages throughout the inner solar system.

Figure 2. Count areas showing: (a) Craters per km², (b) Rock abundance (surface area fraction), (c) regolith nighttime temperature (normalized by latitude).

Figure 3. Crater density versus rock abundance (top) and nighttime regolith temperature (bottom) for two count areas outlined in Figure 1.

Figure 4. CSFDs with absolute model ages of areas with high (blue), intermediate (red), and low (yellow) rock abundance for the count area on the west side of GB.