Geophysical Research Abstracts
Vol. 17, EGU2015-11554-1, 2015
EGU General Assembly 2015

Effects of Count Area Size on Model Ages Derived from Random CSFDs

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As higher resolution imagery becomes available, smaller regions can be studied. These small areas, however, contain fewer craters for crater size-frequency distribution (CSFD) analysis. For example, a study of irregular mare patches (IMPs) on the Moon [1] could only measure craters, at three IMPs, that were large enough for derivation of absolute model ages (AMAs), using the current lunar chronology and production functions (CF/PF, valid for craters 10m<D<100km [2]). Because the young ages of IMPs have significant implications for lunar evolution, the robustness of the AMAs is important.

In addition, young craters used to define the lunar chronology (e.g., North Ray [3] and Cone [4] craters) have small count areas of less than 1 km^2. While, Hiesinger et al. [3] show that ages derived from small areas are consistent with ages of larger areas, they exhibit variability greater than the statistical error bars [3,4]. Pasckert et al. [5] investigated whether 25 4 km^2 count areas within a 100 km^2 count area on mare basalt in Tsiolkovsky crater reproduce the age of the larger area. While 19 of the ages are within the error bars of the large area, six of the ages are not. However, the disparate ages could reflect local resurfacing events associated with later volcanism or impact cratering [5].

To eliminate the effects of local geologic activity such that we can evaluate the effects of count area size alone on the robustness of AMAs, we generated random crater distributions for theoretical lunar surfaces with ages of 0.1-4 Ga. We then analyzed the effects of decreasing count area size on the resulting AMAs. The precision of AMAs is determined by the Poisson cratering process and the non-linearity of the CF for the crater measurements themselves [6]. Smaller count areas have fewer craters, such that this statistical precision decreases. However, our study also shows that the accuracy of the AMAs is decreased for smaller count areas. For example, 4 km^2 areas on 0.1 Ga surfaces typically have 50-100% percent errors, while the same count area sizes on 4 Ga surfaces exhibit percent errors typically <5%. However, even with the inaccuracies for young surfaces ca. 100 Ma in age, the ages of the IMPs can still be confidently interpreted as late Copernican.

[1] Braden et al. (2014) Nature Geosci. 10.1038/NGEO$_2$252. [2] Neukum et al. (2001) Space Sci. Rev. 96, 55. [3] Hiesinger et al. (2012) JGR 117, E00H10. [4] Hiesinger et al. (2015) LPSC 46, 1834. [5] Pasckert et al. (2015) Icarus, in review. [6] Michael and Neukum (2010) EPSL 294, 223.