SECONDARY CRATERING RATES ON THE BASALTIC PLAINS OF MARS AND THE MOON. K. M. Block[1] and N. G. Barlow[2], [1]Florida Atlantic University, Boca Raton, FL 33431, KBlock@netrox.net, [2]Dept. Physics and Astronomy, Northern Arizona Univ., Flagstaff, AZ 86011-6010, Nadine.Barlow@nau.edu.

Introduction: The current method of determining absolute ages of Martian terrain units relies on an extrapolation of the lunar crater chronology curve to Mars. This method utilizes the crater size-frequency distribution of the area in question. Until recently, images used for this type of analysis were relatively low resolution and small craters were difficult to identify. However advances in instrumentation now allow for smaller craters to be classified and thus smaller areas of the Martian surface to be examined in greater detail. Frequently, the small craters revealed in these higher resolution images are secondary craters created by ejected material from primary impacts. When these craters are used in the size-frequency distribtution analysis a new source of possible error is introduced: variation in the secondary cratering rates between the two bodies. If the rates of secondary crater production on the Moon and Mars are statistically similar, the extrapolated crater chronology curve will provide accurate estimates of the ages of Martian surfaces. If however the secondary cratering rates vary from one body to the other, the calculated absolute ages will be innacurate. Previous reseach suggest both a higher frequency of secondary cratering at great distances from the crater [1] and a lower frequency at distances within 2 crater radii of the rim [2].

The pupose of this study is to determine if there exists a statistical difference between secondary cratering rates on the lunar maria and Martian volcanic plains. These areas show more recent volcanism and are more lightly cratered than Martian and lunar highlands, making it easier to distinguish the smaller secondary craters. Their similar basaltic composition also allows for more accurate comparison of cratering behavior. Determining accurate ages for Martian terrain units is crucial in refining our current understanding of the planet's geologic history.

Method: MOC and THEMIS imagery were used to identify Martian primary craters within the volcanic plains. Craters were singled out for further study if associated secondary cratering was apparent and if sufficient images of decent quality of the crater and the surrounding area were available. If full diameter of the primary crater could not be measured through a single image or by creating a composite image, the crater was removed from the study. The secondary craters in this research are small (on the order of 10^2 meters in diameter) in comparison to other, larger surficial features and can therefore be more easily erased from the surface by erosion or other impacts. Primary craters that showed signs of significant erosion were therefore also eliminated, as were craters with a large portion of the secondary crater field lost to another impact. Secondary craters were counted and measured between 1.5 and 6 crater radii and were binned into $\sqrt{2}$ diameter increments.

We then estimated the energy necessary to produce the primary craters on Mars. We used the impact energy-crater diameter relationship (equation 7.8.4 in [3]) and assumed a projectile density of 2500 kg m^{-3}, a target density of 3000 kg m^{-3}, and impact angle of 45°, and an impact velocity of 9.6 km s^{-1}. We then used this same relationship to determine the crater diameter produced by a similar energy impact on the Moon, with an impact velocity of 16.1 km s^{-1}.

Lunar craters closest in size to these calculated diameters were identified and examined using digitized Lunar Orbiter images. Lunar images were then analyzed in the same fashion: secondary craters were counted, measured, and binned according to size. The distribution of secondary craters associated with similar impacts were compared graphically using standard relative size-frequency distribution techniques described in [4] and [5]. Data from similar energy Martian and lunar craters were plotted on the same graphs with error bars to show statistical difference.

Summary: Three graphs were produced, each showing the relative size-frequency distribution of secondary craters produced from at least one lunar and one Martian primary impact of similar energies (Fig. 1-3). In all graphs, a statistical difference was found between the secondary crater size-frequency distribution on the two bodies, with the martian secondary crater frequency greater than the lunar secondary crater frequency. This supports the results from the martian crater Zunil where the secondary crater production is higher than expected [1]. Based on our analysis, we find that the secondary crater production rate is approximately twice as great on martian volcanic plains than on the lunar maria, although further work is needed to confirm this result.

References:

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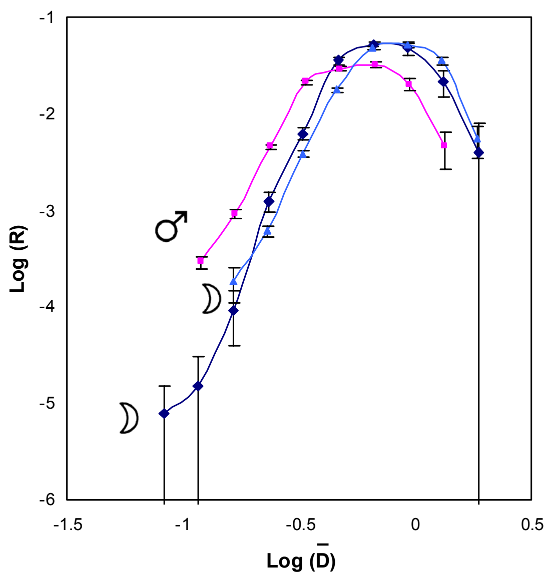

Figure 1. Relative size-frequency distributions for secondary craters associated with Calahorra (Mars), Harpalus (moon), and Aristarchus (moon).

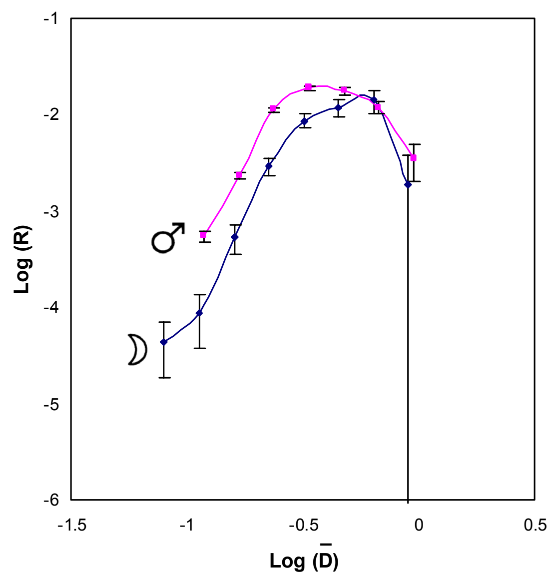

Figure 2. Relative size-frequency distributions for secondary craters associated with Santa Fe (Mars), and Flamsteed (moon).

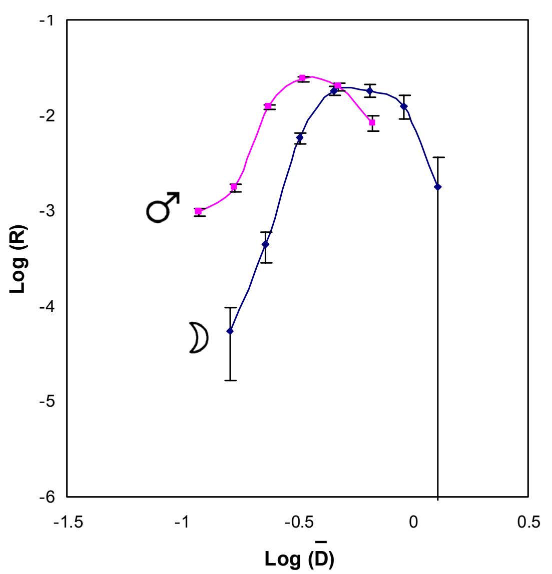

Figure 3. Relative size-frequency distributions for secondary craters associated an unnamed crater at 23°N, 207°E (Mars), and Lambert (moon).