ON THE CONSTANCY OF THE LUNAR CRATERING FLUX OVER THE PAST 3.3 BILLION YEARS, R. Arvidson, E. Guinness, C. Hohenberg, McDonnell Center for the Space Sciences, Washington University, St. Louis, Mo. 63130.

We have examined crater populations superimposed on three reasonably well-dated lunar surfaces for the purpose of calibrating the post-heavy bombardment cratering flux. The surfaces analysed were: (a) the smooth playas located on the continuous ejecta deposit of the crater Tycho, (b) the smooth plains on the northern half of the floor of Copernicus, and (c) the region surrounding the Apollo 12 landing site. Both the playas on Tycho's ejecta deposit, and the plains within Copernicus, appear to cover and embay rougher, more highly cratered topography associated with the two respective craters. As such, the playas and plains either post-date the cratering events or they represent one of the last surfaces to form during the events. In either case, these two surfaces are the best for sampling the crater populations that post-date Tycho and Copernicus. Tycho seems to be about 100 m.y. old, based on clustering of cosmic ray exposure ages at Apollo 17 (1). $^{39}Ar/^{40}Ar$ correlated gas analyses of Apollo 12 KREEP glass may date Copernicus at 800 $\pm$40 m.y. (2). Also, U-Th-Pb systematics of the KREEP glass imply an age of 850 $\pm$100 m.y. (3) and K-Ar data imply an age of $\sim$ 800 m.y. (4). Finally, Apollo 12 region contains basalts that have the youngest crystallization ages of mare material returned from the moon. As such, this area is the best of the available mare regions for acquiring data for examination of the nature of post-heavy bombardment cratering population. The average crystallization age of nine Apollo 12 samples is 3.26×10^9 years (5).

Results of weighted, least squares fits to crater populations on the three surfaces are as follows (Figure 1):

(1) $\log N_{Tycho} = (-3.10\pm.10) + (-3.75\pm.07)\log d$

(2) $\log N_{Cop} = (-2.25\pm.06) + (-3.68\pm.06)\log d$

(3) $\log N_{A12} = (-1.74\pm.03) + (-3.77\pm.03)\log d$

where N is the frequency of craters/km^2 of size d, where d is in kilometers. Errors represent plus and minus one standard deviation about the estimated intercept and slope, where the deviation is due to deviation of the regression line from the data points.

Based on statistical analyses of fits to the data, the following conclusions can be drawn:

(a) There are no significant changes in slope for the three surfaces. Similarities in slope imply that the crater populations are dominated by primary craters since it is unlikely that three surfaces of vastly differing age could be mixtures of primaries and secondaries and still have similar slopes. A similar conclusion has been reached by Neukum et al (6).

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(b) The frequency/km^2 of craters for the mean crater diameter sampled for the three surfaces is plotted versus the age of the surface in Figure 2. An error-weighted least squares fit through the three points goes nearly through the origin. Statistical analysis of the fit implies that there is no basis for assuming that the cratering rate has changed over the past 3.3×10^9 years. With a production function and cratering rate established it is now possible to date intermediate-aged lunar surfaces, but only if it can be rigorously shown that the slope describing the given crater population is indistinguishable from that obtained for the three calibration functions. Even when this condition is fulfilled, age estimates will be hampered by relatively large, time dependent uncertainties due to uncertainties in estimating the calibration populations and by the fact that only three surfaces (3 ages) can be used to predict the cratering rate.

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Figure 1: Crater size-frequency/area data and log-log linear least squares fits for the three calibration surfaces. The method advocated by Chapman and Haefner (7) was used to reduce the data, along with a further stipulation that crater diameter sampling intervals be greater than or equal to intervals that would provide only a 5% chance of not properly sampling a random sample of a given population. Counts were made from Lunar Orbiter imagery. Each type of symbol for Copernicus and Apollo 12 indicates a single Orbiter frame. For Tycho, 24 playas (and 7 frames) were included in the counts.

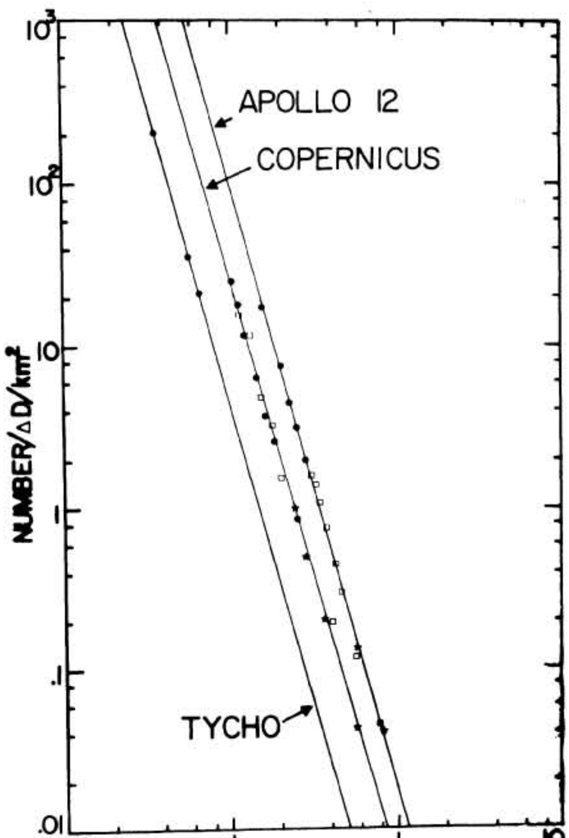

Figure 2: Plot of the frequency/area for the geometric mean crater size sampled for all surfaces versus the age of the surface. Values and error bars for frequency/area were computed from equations (1), (2), and (3). Error in age for Copernicus indicates the approximate discordancy in ages derived for the KREEP glass. The solid line is the error-weighted linear least squares fit through the data.