DEGRADATION TRENDS OF MERCUIAN CRATERS AND CORRELATION WITH THE
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Impact craters are the dominant landforms on Mercury and the Moon. These craters represent standard experiments repeated ad infinitum on each planet and thus provide a statistical tool for examining the cratering process itself, probing the target planet, and gauging the degradation processes effecting the craters. Numerous studies have documented subtle interplanet variation in fresh crater morphology apparently due to differences in physical characteristics of projectiles and planets. The present preliminary study reports changes in morphological characteristics of mercurian craters with increasing degradation, to provide evidence on degradation processes on Mercury and to correlate degradation sequence and style with major geologic time periods and events.

The investigation is based on morphological data for the 650 mercurian craters with diameters >20 km in the Brown University data bank and is modelled on previous studies of degradation of lunar craters. Degradation states of mercurian craters are classified on a scale from 1 to 5 according to the scheme devised by Arthur for lunar craters, with class 1 having sharply defined rims while class 5 craters are extremely battered and fragmentary. Geologic time runs from class 5 to 1. Figure 1 summarizes changes in morphological features of mercurian crater >20 km with degradation class/geologic time. Crater rays are the first feature to disappear on Mercury as on the Moon, however satellitic craters are associated with much more highly degraded craters on Mercury than is common on the Moon. Our statistical data thus confirm this previously noticed significant difference between craters on Mercury and the Moon. A related anomalous characteristic of mercurian craters is the persistence of raised rims throughout geologic time. This may result from the concentration of ejecta near a crater's rim due to Mercury's large gravitational field as suggested by Gault et al. and Head et al.

Mercurian craters are commonly circular but their circularity decreases from class 2 to 5 as crater rims become poorly defined. Polygonal rim outlines that occur on Mercury are neither as common nor as systematically developed as on the Moon, and our data show little evidence for a mercurian grid system. Rim crest continuity falls off rapidly and regularly from class 1 to 3, due to superposition of craters on rims, indicating progressive degradation due to impacts.

There is a smooth decrease from class 1 to 3 in the percentage of craters considered to be deep, suggesting a progressive shallowing with increasing degradation. The distribution by class of terraces in craters has a trend very similar to that of the depths, and central peak occurrence follows a similar pattern. Thus, crater depth decreases, and continuous rims, central peaks, and terraces all systematically decrease in abundance from class 1 to 3, but at class 3 there is an inflection point and from class 3 to 5 the various morphological features do not decrease at the same rate as before (Fig. 2). Preservation of all morphologic features is more complete for classes 1 and 2 than if degradation had proceeded at the same rate as during the epoch.
DEGRADATION TRENDS OF MERCURIAN CRATERS
Wood, Charles A.

from class 5 to 3. Thus a major change in the rate, and presumably style, of degradation occurred during class 3 time.

Head found that crater degradation on the Moon could also be divided into two time periods based on differing styles and rates of crater degradation processes. Period II degradation has occurred since about 3.9 b.y. ago and is characterized by slow, continuous erosion of crater morphologic features by subsequent impacts. Period I, prior to 3.9 b.y. ago, was characterized by a very high impact rate and the formation of multi-ring basins; these two factors caused rapid destruction of craters. Thus the boundary between lunar crater degradation periods I and II corresponds to the termination of the early period of intense bombardment.

Based on the data in Figure 2, the end of the period of heavy bombardment and basin formation on Mercury occurred between the middle of class 2 and class 3 epochs. Crater class distribution maps show that Caloris basin formed during the class 2 epoch. This closely parallels lunar degradation history, where the end of heavy bombardment occurred between the middle of class 2 and 3 epochs and Imbrium and Orientale formed during class 2 time.

Evidence concerning the time of formation of the smooth plains (SP) which fill and surround Caloris also comes from distribution maps of each degradation class of mercurian craters. Craters formed from class 5 through class 2 time are more abundant on the ancient heavily cratered and intercrater plains terrains than on SP. However, class 1 craters appear to have nearly the same crater density over all of Mercury. This implies that the mercurian smooth plains were emplaced near the boundary between the class 2 and class 1 epochs.

The lunar maria were also formed around the boundary between degradation classes 1 and 2. Thus, major events in the development of the Moon and Mercury-termination of heavy bombardment, basin formation, and smooth plains/maria emplacement—occurred at the same degradational stages in the history of the two planets.

DEGRADATION TRENDS OF MERCURIAN CRATERS

Wood, Charles A.

Fig. 1: Changes in mercurian crater morphology with age.

Figure 2:
DEGRADATION TRENDS IN MERCURIAN CRATERS

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