THE CRATERING RECORD ON TRITON; R. G. Strom, S.K. Croft, Lunar and Planetary Laboratory, Univ. of Arizona, and J. M. Boyce, NASA Headquarters

Impact craters on Triton are rare to nearly absent at the 3 to 1.8 km resolutions acquired on the mapping sequence of Voyager 2. There are no multiring or peak-ring basins. Fresh impact craters displaying sharp rims with bowl-shaped interiors, or flat floors with central peaks, range in size from the resolution limits of the images (about 1 km) up to 27 km. The transition diameter from simple to complex craters occurs at a diameter of about 11±2 km, which is consistent with the transition diameters for craters on other icy satellites when their surface gravities are taken into account. The depth/diameter ratio of Triton's impact craters (6 measurements) is commensurate with the depth/diameter ratios on other icy satellites. For example, a 15 km diameter complex crater is about 1.4 km deep, and a 5 km diameter simple crater is about 0.65 km deep. The craters do not show recognizable ejecta blankets or interior terraces, but this is probably due to the low resolution of the images. Lunar craters of comparable diameter also do not show ejecta blankets or terracing at similar resolutions. The craters also do not display either light or dark rays. This could be due to the high albedo of the surface and/or darkening of light rays by micrometeorite gardening or radiation darkening. The lack of dark ray craters, which are apparent on other icy satellites at comparable resolutions, may place constraints on models of dark ray formation. There are several large circular features up to about 50 km in diameter in the frost-covered southern hemisphere and near the "cantaloupe" terrain that could be impact craters dating from an earlier period of heavy bombardment. However, these features have been so degraded and modified by internal processes, possibly including viscous relaxation, that all morphological signatures ,except their circularity, have been erased. Whether these structures are ancient impact craters is highly uncertain at this time.

The imaged surface of Triton was divided into four areas, indicated by solid outlines in figure 1. Area 1 is the most heavily cratered region and occurs between about 30 and 70 degrees longitude. Area 2 is the most lightly cratered region and coincides with the lake-like features between about 0 and 30 degrees longitude. Area 3 is largely the "cantaloupe" terrain, and Area 4 is a portion of the frost covered southern hemisphere. At this time crater counts on the "cantaloupe" terrain are unreliable and, therefore, are not shown. Because of the nature of this terrain and the low resolution at which most of it was imaged, impact craters are extremely difficult to recognize with any degree of certainty. Although impact craters probably occur on this terrain, their number and diameters are uncertain at this time and comparisons with other areas could lead to erroneous interpretations. However, a small portion of this terrain imaged at a resolution of about 2 km has a very low crater abundance possibly comparable to that of area 2.

Figure 2 is an R plot of the crater size/frequency distribution for Areas 1,2, and 4 compared with those of the lunar highlands, the lunar post-mare and the fresh crater population on Miranda. The crater density for the most heavily cratered terrain (Area 1) is essentially the same as that of the lunar post-mare over the same diameter range. Although the statistics are poor, both Area 2 and Area 4 are at about the same longitude and have the same crater density suggesting that the frost covered southern hemisphere and the "lake" region are about the same age. They have a crater density about half that of Area 1. Furthermore, the crater density on the "lakes" near the terminator is much lower (only two craters) than on the smooth terrain immediately to the east, indicating the "lakes" are younger. Although Area 1 is the most heavily cratered region on Triton's imaged surface, it is not necessarily the oldest surface. This part of Triton constitutes the leading hemisphere in its orbit around Neptune and therefore impacts will be more frequent and at higher velocities than elsewhere on the satellite. The crater frequency should decrease from the apex to the antapex of motion as observed. Furthermore, the three largest craters observed all occur within about 50 km of each other and nearer the apex of motion than most other craters in the region. Therefore, the relatively high crater density in Area 1 compared to other areas could be wholly or partly due to a leading/trailing asymmetry in the crater production rate. If this is the case then determining relative ages form crater abundances on relatively widely separated terrains could lead to erroneous results. This method of age dating should only be attempted for adjacent terrains at similar longitudes. Even then the uneven resolution and very low crater abundances make this method very uncertain.

We attempted a more refined estimate of the leading-trailing asymmetry by counting craters in the areas denoted by dashed lines in figure 1. These areas were chosen to encompass similar geologic provinces to eliminate real geologic age differences as much as possible. The approximate bounding longitudes and cumulative number of craters above 4 km in diameter of each area are, respectively: 60-75^0 and 13±3 /10^6 km^2, 30-60^0 and 12±3 /10^6 km^2, and 0-30^0 and 6±2 /10^6 km^2. These statistics are marginal but broadly consistent with a factor of 2 decrease in crater density between the leading edge and the boundary between the leading and trailing hemispheres.

A comparison of Triton's and Miranda's cratering record sheds some light on the origin of the impacting objects. The crater statistics in lightly cratered areas are too poor and have too small a diameter range to be much help in determining the crater size/frequency distribution, thus only Triton's most heavily cratered terrain (Area 1) is considered to provide a fairly reliable indication of the crater size/frequency distribution. Figure 2 shows the impact crater size/frequency distribution for the craters in area 1 on Triton and for fresh craters on Miranda. Both distributions have about a differential -3 slope, and an upper diameter cut-off of about 25-30 km. The density of the fresh craters on Miranda is about an order of magnitude higher than the craters on Triton. The distribution for craters on the lunar maria, also shown in figure 2, has a slope and density similar to Triton's, but the upper diameter cut-off is near 100 km. The largest undisputed crater on Triton is 27 km in diameter, and Triton is large enough that craters larger than 30 km should occur if sufficiently large projectiles were present in the impactor population. Thus the lower cut-off for crater (and impactor) sizes on Triton and Miranda relative to the Moon could be real and reflect a difference in the respective impactor size distributions. On the Moon this population must contain a substantial number of asteroids which are not present at Uranus and Neptune.

In addition to similar population statistics, both the craters on Triton and the fresh craters on Miranda appear to exhibit leading-trailing asymmetries. Since Miranda is in prograde orbit, the leading/trailing asymmetry most likely indicates a source population external to the uranian system: i.e., comets. The possible leading/trailing asymmetry for Triton's craters is also consistent with a cometary origin, but unfortunately not diagnostic. This is because Triton's orbit is retrograde and therefore planetocentric objects in prograde orbits (which were almost certainly present) will also preferentially impact on its leading hemisphere. This is consistent with Goldreich's (1) model for Triton's capture, which proposes an initial eccentric orbit and tidal heating followed by circularization of the orbit and sweep-up of objects in prograde orbits. Therefore, the cratering record could be the result of sweep-up of the prograde planetocentric objects near final circularization of Triton's orbit and after resurfacing. Thus, even though similarities of Triton's and Miranda's fresh crater populations favor a similar cometary origin for both, a planetocentric origin for the craters on Triton cannot be ruled out.

REFERENCES

1. Goldreich, P. et al., **Science**, 245, pp. 500-504, August 4, 1989.

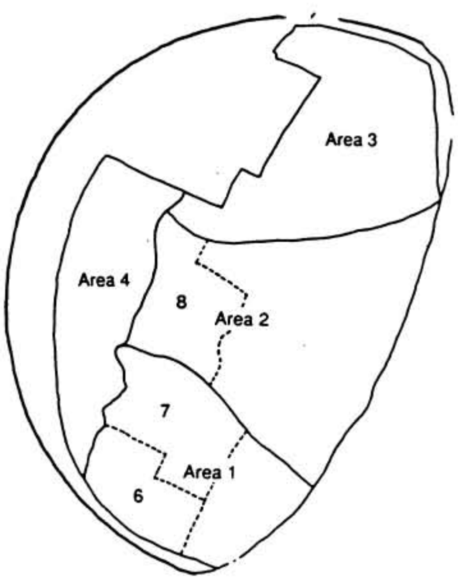

Figure 1. Location map of areas on which crater counts were performed. Area 1 is the most heavily cratered and corresponds to the Triton HC curve in Figure 2. Area 2 is lightly cratered and corresponds to the Triton LC curve in Figure 2. Area 3 is the Cantaloupe terrain and not yet fully analyzed. Area 4 is a portion of the frost covered southern hemisphere and corresponds to the Triton SH curve in Figure 2. The dashed areas (6,7 and 8) are the areas counted to determine if a gradient in the crater density exists. These areas all consist of similar terrain.

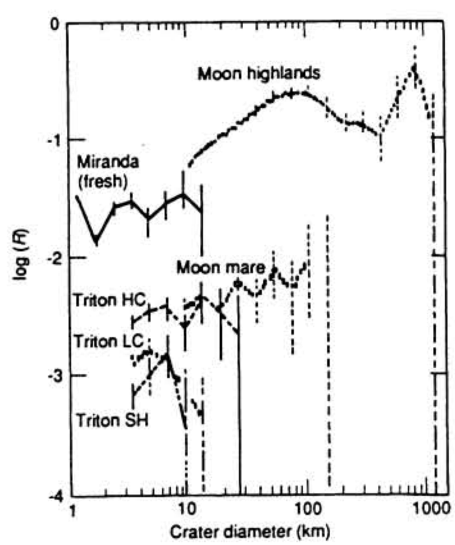

Figure 2. R plot of the Triton crater size/frequency distribution for Area 1 (Triton HC), Area 2 (Triton LC) and Area 4 (Triton SH) compared with the fresh crater population on Miranda, the lunar highlands and the lunar post-mare.