CRATER FREQUENCIES ON GANYMEDE AND THEIR IMPLICATIONS

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Crater frequencies have been measured for twenty different regions, each of uniform morphology, on the leading hemisphere of Ganymede. Counts were made in regions of reticulate terrain, dark (cratered) terrain, and in grooved terrain ranging from craterless to densely cratered.

Smaller craters in the dark terrain are nearly invisible due to lack of albedo contrast, therefore the data may be less accurate at this size range. In the bright grooved terrain, many craters are buried by the ice. These were excluded from the counts when possible, but some contamination of the data may be present from these. In addition, the data may be affected by counts of secondary craters, though areas chosen for inclusion were far removed from obvious secondary fields.

The dark terrain is the most densely cratered unit on Ganymede, with crater densities ranging from about 200 to 2000 per 10^6 km^2, for craters ≥10 km in diameter. These counts are higher than those presented earlier by Shoemaker, *et al.* (1981). The dark terrain on Ganymede is comparable in crater density to regions on several of the Saturnian satellites (Plescia and Boyce, 1981a and 1981b).

Crater densities in the grooved terrain are widely ranging. Most regions of this type have less than 200 craters per 10^6 km^2 (D ≥10km), and the crater frequency curves have gentler slopes than those for the dark terrain. However, there are areas of grooved terrain on Ganymede which exhibit crater densities as high as areas of dark terrain. The inclusion of these older grooved terrains in the crater distribution diagram (Figure 1) provides a smooth transition in the crater frequencies between the two terrain types. This suggests that grooved terrain formation was initiated before the termination of initial heavy bombardment, and has continued until very recently.

Formation of furrows in the dark cratered terrain appears to have preceded the formation of any craters presently seen on Ganymede. Not a single feature has been seen on the planet which has been modified by a furrow. Furrow formation appears to have been a distinct episode in the history of Ganymede.

The crater frequencies in the bright grooved terrain also suggest that the actual formation of grooves in the bright lane occurs a significant time after formation of the bright lane itself. Numerous areas on Ganymede show craterless grooveless lanes merging with a narrow fissure (Figure 2). These fissures commonly transect any other type of terrain or boundary, and exhibit both lateral widening and strike-slip motion. The grooveless streak commonly merges with larger areas of grooved terrain.

We therefore propose as a scenario for grooved terrain formation the initial opening of a fissure, followed by the deposition of surface water-ice. The visibility of buried craters through more recent ice flows suggests that the bright lane deepens and widens with age. Groove formation usually is the third phase of lane development. Finally, continued cratering erodes and darkens the grooved terrain until the albedo and topography approach those of the older cratered terrain.

Reticulate terrain on Ganymede exhibits crater densities of ≤200 craters (≥10 km) per 10^6 km^2. Similar terrain on Enceladus ("fractured terrain") has a somewhat higher density of craters (Plescia and Boyce, 1981b).

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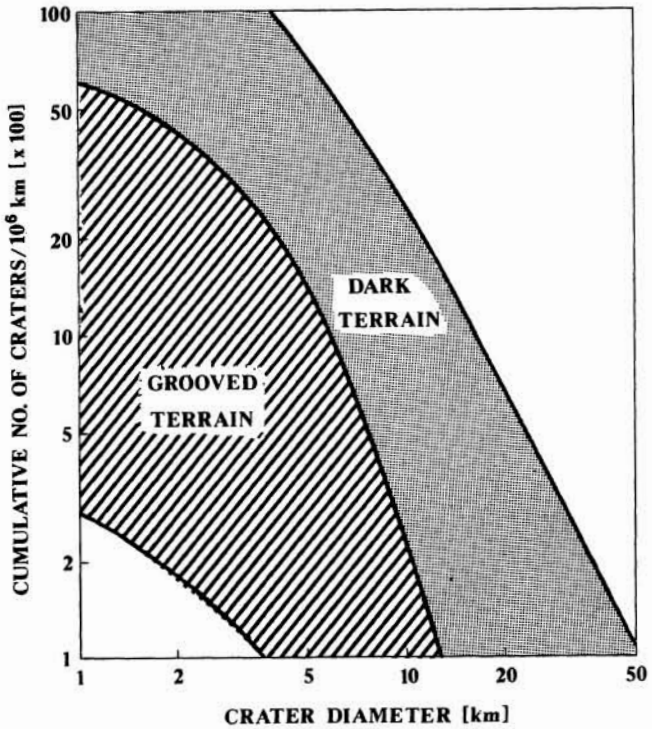

Figure 1. *Crater density distributions for different terrains on Ganymede. The boundary between the older grooved terrain and the dark terrain is indefinite, due to considerable overlap. When curves for individual areas are plotted, those for newer grooved terrain exhibit gentler slopes than those for the dark terrain.*

Figure 2. *Voyager 2 photo showing different stages of formation of grooved terrain. Notice craters (A) and other bright terrain (B) transected by initial fissures. The crater at (C) is both split by a fissure and shallowly buried by ice flows. Grooved terrain forms over other terrains; no stoping is involved.*