CRATERING HISTORY OF MIRANDA J.B. Plescia, U.S.G.S., Flagstaff, AZ 86001, and J.M. Boyce, NASA Headquarters, Washington, D.C. 20546

The surface of the southern hemisphere of Miranda imaged by Voyager 2 (Smith et al., 1986) is divisible into two general types of terrain: cratered terrain, characterized by numerous craters and undulating intercrater plains; and basins, circular to rectangular areas of complex morphology having large-scale albedo markings. (The term "basin" is used without a genetic implication.) To determine the relative ages of the terrains and the length of geologic activity, crater-frequency data were compiled for various parts of the cratered terrain and the basins (Table 1).

All of the well-resolved impact craters are either bowl shaped or flat floored; craters having central peaks or rings were not observed. Almost all craters >20 km in diameter are degraded and some are barely detectable. Smaller craters range in appearance from fresh to degraded. Ejecta deposits are generally absent, although two craters are surrounded by low-albedo ejecta material.

The cratered terrain has a varied crater frequency that, in part, is related to position on the satellite. From the anti-Uranian hemisphere (long 180^{o}) to the sub-Uranian hemisphere (long 0^{o}), from areas A to B to C, crater frequencies decrease by an order of magnitude (Table 1). Differences in crater frequencies and the shape of the cumulative size-frequency distributions indicate a resurfacing of the cratered terrain, the sub-Uranian hemisphere having been more affected than the anti-Uranian hemisphere.

Within the cratered terrain in the anti-Uranian hemisphere, near lat -50^{o}, long 180^{o}, the size-frequency distributions correspond to those of steady-state surfaces on the Moon. This correspondence indicates that the cratered terrain is locally saturated with craters <7 km in diameter.

A gradient in the cratering rate from the leading to the trailing hemisphere (Shoemaker and Wolfe, 1982; Horedt and Neukum, 1984) can explain the observed pattern of resurfacing and the correlation of crater frequencies with position within the cratered terrain. The data suggest that Miranda originally was oriented about 90^{o} from its present orientation, such that the most heavily cratered areas that are now near long 180^{o} were originally near the apex of motion (long 90^{o}). Resurfacing within the cratered terrain resulted from the ballistic distribution of ejecta that eroded and buried all craters to some extent but was most effective on the small ones. Apparently, as a result of the formation of the basins, Miranda's moments of inertia were changed, resulting in a reorientation of the satellite.

The banded basin in the leading hemisphere consists of a smooth interior area and a marginal area characterized by albedo banding resulting from concentric, outward-facing scarps. The interior has a higher crater frequency than the margin (Table 1). Although the frequency difference is statistically significant, it may not reflect a real difference in formation ages: the extensive faulting in the margin might have obliterated craters, thereby lowering the observed crater frequency and the apparent age.

The grooved basin in the trailing hemisphere consists of an interior area, characterized by randomly oriented ridges and troughs, and a marginal area, characterized by parallel, closely spaced ridges and grooves. The interior has a significantly higher crater frequency than the margin (Table

1). All of the craters within the margin are superposed; none appear to be affected by the grooving, indicating that the frequency represents a formation age rather than a crater-retention age.

The polar basin was divided into four areas: the bright chevron-shaped feature, grooved area A (near lat -70^{o}, long 300^{o}), grooved area B (near lat -55^{o}, long 340^{o}), and a boundary area that partly surrounds the other areas. Three areas--the chevron, grooved area A, and the boundary area--have similar crater frequencies (Table 1), indicating that they developed contemporaneously. Grooved area B has statistically higher crater frequencies, which may represent a crater-retention rather than a formation age. This area may have formed by the tectonic disruption of adjacent cratered terrain and it may have inherited some preexisting craters. This may explain why the crater frequencies for grooved area B are lower than those characteristic of the cratered terrain but higher than those of a "new" surface of the same age that was originally uncratered.

Crater-frequency data indicate that the cratered terrain is the oldest terrain on Miranda and that it has been locally resurfaced. Ages of the grooved and banded basins are similar but younger than the cratered terrain, and the polar basin is the youngest terrain. Observed crater frequencies on Miranda are, in general, lower than those on any of the other Uranian satellites, indicating that Miranda's surfaces are the youngest in the system. Miranda's relative youth is even more apparent when the increase of the cratering rate inward from Oberon is considered; the cratering rate at Miranda is about 14 times that at Oberon (Smith et al., 1986). Thus, a surface on Miranda dating to the same period as does Oberon's would have about 20,250 craters $\geq$ 10 km in diameter/10^{6} km^{2}. However, the observed crater frequencies on Miranda (Table 1) are several orders of magnitude lower. Apparently, the recorded geologic history of Miranda began after the heavy bombardment had ended and after much of the activity on the other satellites had ceased.

REFERENCES: Horedt, G.P., and Neukum, G., 1984, Icarus, 60, 710-717; Shoemaker, E.M., and Wolfe, R., 1982, Satellites of Jupiter, 277-339; Smith, B. A., et al., 1986, Science, 233, 43-64.

TABLE 1
MIRANDA TERRAIN CRATER FREQUENCIES

REGION	**FREQUENCY OF CRATERS $\geq$ D / 10^6 KM^2** **DIAMETER (KM)** **1**	**2**	**5**	**10**	**20**
POLAR BASIN					
Grooved A	10763±1345	2523±651	(283±218)	(58± 99)	(12±45)
Grooved B	22038±1805	5916±935	908±366	(227±183)	(60±94)
Chevron	16440±1911	2222±703	(156±186)	(21± 68)	(2±21)
Boundary	8561±1468	1740±662	348±292	(91±151)	(21±73)
Average	15157± 846	3352±398	338±126	(56±51)	(10±22)
GROOVED BASIN					
Margin	(7263±559)	1737±273	355±124	151± 81	(16±26)
Interior	(10325±1042)	3371±596	794±289	206±147	(77±90)
BANDED BASIN					
Margin	(1E5±2206)	(12115± 768)	730±188	115± 75	18±29
Interior	(93886±2057)	(59948±1644)	1307±243	232±102	60±51
CRATERED TERRAIN					
A ($-70^o/235^o$)	15599±1789	7800±1265	2175±668	1017±457	(415±292)
B ($-40^o/270^o$)	11034±1077	3153±576	736±278	155±126	(44±68)
C ($-30^o/315^o$)	7240±800	1126±315	581±123	435±196	177±125
D ($-65^o/130^o$)	38312±1880	9045±914	1477±369	233±146	(62±76)
E ($-75^o/175^o$)	(30037±3440)	9846±1969	2757±1042	(924±603)	(325±358)
F ($-65^o/175^o$)	(32483±1250)	10419±708	2357±337	(667±179)	(235±106)
G ($-35^o/195^o$)	(32650±1472)	10325±828	2523±409	598±199	(253±130)
H ($-45^o/225^o$)	(25230±1627)	7658±896	2046±463	590±249	(195±143)

Numbers in parentheses are extrapolations of the data to diameters at which craters of a given size were not present (at the large-diameter end) or at which resolution, viewing, or lighting limitations prohibited accurate counting (at the small-diameter end).