CRATER MORPHOLOGY AND MORPHOMETRY ON THE URANIAN SATELLITES,
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Crater Morphology. Fresh craters on the icy Uranian satellites exhibit a range of morphologies similar to craters on the icy satellites of Jupiter and Saturn. Craters on the large satellites Ganymede and Callisto show a progression of crater morphologies with increasing crater diameter: simple craters, complex craters, pit craters, and multiring structures at the largest diameters. Craters on the smaller Saturnian satellites are almost exclusively simple or complex in morphology, pit craters being generally absent. Craters on the Uranian satellites also include simple and complex craters, but no obvious multiring basins occur. However, the two largest craters on Titania, with diameters of about 335 km (about 10°S lat., 280° long.) and 146 km (about -15°, 40°), appear to be pit craters. Complex craters on the Uranian satellites show the same general structural features found in complex craters on the other icy satellites: a) central structures are usually single peaks, circular or linear elongate in planform. A large conical peak approximately 8 km high visible on Oberon's limb is morphologically similar to the distinctive large central peak in Izanagi on Rhea. Albedo patterns and irregularities in Oberon's limb around the peak suggest a crater rim around 300 km in diameter, again comparable to Izanagi. b) Terrace structures are very underdeveloped compared to terraces in complex craters on the terrestrial planets. No true terraces are apparent, and only slump deposits at the bases of rim scarps are found (though this may be a resolution effect). c) The planforms of complex crater rims are frequently polygonal like complex craters on rocky planets.

Simple-Complex Transition Diameters. Estimates of transition diameters from simple to complex crater morphologies are given for the five large Uranian satellites and 1985U1 in Table 1, and plotted with transition diameters on other bodies against surface gravity in figure 1. The transitions on Ariel and Titania are well determined. The other transitions are only bracketed by approximate limits. The lower limit on Miranda is well determined, but the upper limit is set by a single degraded structure that is complex if it is a single crater and not a degraded cluster. The upper limits on Umbriel and Oberon are well defined, but the lower limits are somewhat uncertain due to poor resolution. The lower limit on 1985U1 is based on a single large crater which (again subject to resolution limits) appears to be simple. Two simple theories of crater modification (1,2) suggest an inverse correlation of the transition diameter with surface gravity. The difference in transition diameter between sedimentary (s) and crystalline (c) rocks on the Earth suggest a direct dependence on target strength or density as well (1,3), a dependence further indicated by the general downward shift of the transition diameters on the icy satellites relative to the rocky terrestrial planets. However, adopting a g^{-1} dependence for the icy satellites seems to indicate two ice sequences: one including Ganymede, Callisto and most of the Uranian satellites, and a second including the Saturnian satellites, Miranda, and Ariel. One might suggest a compositional difference was responsible since the Uranian and Jovian satellites have similar uncompressed bulk-densities while the Saturnian satellites are somewhat less dense, but Titania and Ariel with the best determined transition diameters are on separate "sequences." Apparently other factors affect transition diameters not fully accounted for in current theories.

Possible Large-Scale Impacts. One of the unusual dark structures on Miranda, the "banded ovoid" (1) centered near 15°S lat. and 50° long., occupies a quasi-circular area about 320 km in diameter (figure 1). Crater counts on the dark material and the surrounding light "highlands" demonstrate that the dark terrain is substantially younger than the light terrain. Stereo imagery and limb profiles show that the light terrain slopes down to the contact with the dark terrain, suggesting that the dark terrain fills a previously existing depression. This old depression is inferred to be an impact scar by several observations: 1) strings of overlapping craters morphologically similar to secondary crater chains around large lunar basins extend radially away from the depression center along the terminator. The largest individual craters in the string are 14 to 18 km in diameter, appropriate for a 300 km primary crater (4). 2) Several fractures and two valleys similar to Vallis Bouvard at Orientale Basin on the Moon extend radially from the depression. 3) A tongue of material similar to ejecta deposits around lunar basins obliterates the rim of a 60 km crater ("A") adjacent to the depression and covers most of the floor. 4) Craters on the light terrain fall into two preservation classes: fresh and sharp rimmed, and extremely subdued and degraded with virtually no intermediate states. In addition, a layer of bright material at least 1 km thick appears to cover most of the visible hemisphere (5). Both of these observations may be accounted for if the depression is an impact crater: the light layer representing the thick ejecta blanket that covered and "softened" all pre-existing topography, thus providing a stratigraphic horizon upon which later fresh appearing craters formed.

Another possible modified large-scale impact is located near 10°S lat. and 30° long. on Ariel (figure 2). The structure is a roughly circular depression about 245 km in diameter surrounded by massifs that occur in linear chains that radiate away from the depression center and merge into the surrounding dissected plateau region. An excess of 10-12 km diameter craters that are the right size and radial distance for a 200-250 km diameter primary crater occur on plateaus surrounding the depression. Several large valleys are also sub-radial to the depression. The floors of the depression and the radial valleys are entirely covered by the smooth material that covers the floors of the large linear valleys to the south and west. The general arrangement is reminiscent of some of the large impact basins on Mars, such as Argyre and Chryse, which act as topographic lows towards which flow has occurred.

References

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TABLE 1. SIMPLE-COMPLEX CRATER TRANSITIONS ON THE URANIAN SATELLITES

Name	Radius*, km	Density*, g/cm³	Surface Gravity cm/s²	Simple-Complex Transition Diam., km.
1985U1	85 ± 5	(1.4)	(3.3)	>48
Miranda	242 ± 5	1.26 ± 0.39	8.5 ± 2.6	≈ 28 → 41
Ariel	580 ± 5	1.65 ± 0.30	26.7 ± 5.1	13 ± 2
Umbriel	595 ± 10	1.44 ± 0.28	23.9 ± 5.1	≈ 23 → 38
Titania	805 ± 5	1.59 ± 0.09	35.8 ± 2.2	24 ± 2
Oberon	775 ± 10	1.50 ± 0.10	32.5 ± 2.6	≈ 29 → 45

*Radii and densities adapted from Smith et al. (1986) except for density of 1985 U1 which is a nomimal average uncompressed density for other satellites.

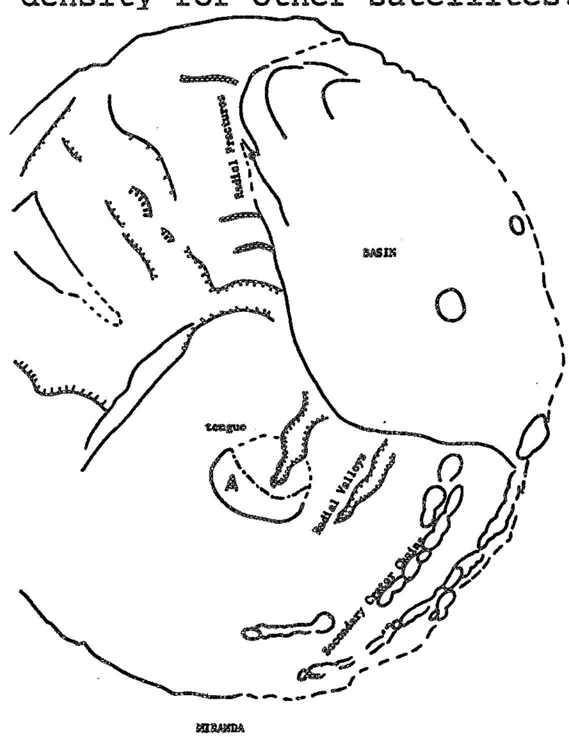

Figure 1.

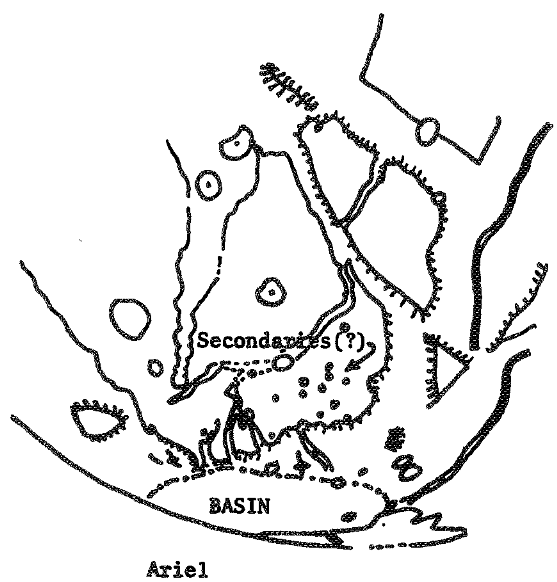

Figure 2.