Triton: Geology and Geologic History
S.K. Croft, Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ, 85721.

Triton was revealed by Voyager 2 to have one of the most complex assemblages of surface features found on the icy satellites (1). An equally complex geologic history is implied. A preliminary geologic map (from which the simplified map in 1 is taken) and history are presented here.

Geologic Units. Figure 1 is a geologic sketch map based on the orthographic photomosaic in 1. Many of the units are gradational into each other, so some of the boundary lines are approximate. The "cantaloupe" terrain is divided into two subunits: 1) ridged plains (Cr) characterized by linear ridge segments with rugged, often pitted, crests separated by smooth topographic lows, and 2) the dimpled plains (Cd), which also contain numerous sub-circular dimple-like depressions. The origin of the dimples is unknown, suggestions include circular volcanic constructs and old mantled impact craters. Three subunits of smooth plains are mapped: 1) smooth valley plains (Sv) occur on the floors of four terraced depressions, or "lakes". The plains are very smooth and embays all irregularities of the lakes' rims. A cluster of irregular pits (generally with a largest central pit) is found on each deposit. 2) The laminated smooth materials (Sl) occur in a zone around the equatorial lakes and consist of irregular flat areas at different elevations separated by scarps a few hundred meters high. Some of the scarps may be tectonic. 3) The high smooth plains (Sh) are flat to undulating smooth materials around several large quasi-circular depressions and strings of irregular rimmed and rimless pits reminiscent of terrestrial cinder cones along erupting fissures. The unit superposes everything else (except small impact craters) and appears to stand somewhat above the surrounding terrains. The patchy smooth (Ps) unit consists of rugged and pitted ridges surrounding patches of smooth material in topographic lows. The unit appears transitional between the smooth plains and the cantaloupe terrain, which it borders. The knobby materials (Tk) occur in large patches within and around the high smooth plains and consist of groups of roughly equidimensional knobs 3 - 5 km across located on the floors of irregular depressions. The mottled hummocky (Th) materials occur in a band south of the high smooth plains and appear to emerge from underneath the smooth materials. The "hummocks" include domes and smooth ridges typically 10 km across, and a few lobate structures associated with the raised ridge. The mottling is most apparent near the boundary with the polar units. The dark smooth material (Sd) is gradational with the darker material of the mottled hummocky materials, which it borders. The linear ridge materials (Rl) occur in strips of single or multiple ridges 20-25 km wide, a few hundred meters high, and up to 1000 km long. The ridge materials are smooth and may have lobate edges. The bright spotted terrain (Bs) is a polar unit characterized by a matrix of very high albedo materials within which darker spots shaped like water droplets on oil occur. The dark spots stand high, and are quite rigid: impact craters are preserved in them. The bright materials have variable thicknesses: the coating on the spots is thin enough (a few meters) to allow the darker albedo to show through, whereas in the lows between the spots, the materials are thick enough (tens to a hundred meters) to bury piece-wise a 5 km wide ridged trough that passes from the smooth dark terrain into the polar deposits. The bright rough terrain (Br) is also a matrix of bright material with imbedded dark rugged ridges. The unit appears to be ridged cantaloupe terrain with bright polar material filling the topographic lows. The bright streaked terrain (Bst) is relatively featureless except for the oriented dark streaks. The features of the spotted and rough bright units disappear gradually into the streaked unit, suggesting burial with increasing southern latitude by an ever thickening layer of polar materials. Dark lobate materials (Ld) are very dark (albedo 0.2) deposits occurring in small patches typically a few kilometers wide and up to 10 km long. The patches occur in a broadly elongate field about 800 by 1000 km near the center of the map. The deposits superpose everything except the bright deposits, so they are geologically late.

The bright materials are interpreted to be seasonal (1). The various smooth, knobby, linear ridge, and dark lobate deposits are interpreted as cryovolcanic (1,2). The origin of the cantaloupe terrain is uncertain, particularly the dimples. Proposals include heavily modified impact craters and some form of cryovolcanism.

Geological History. Crater-count statistics are poor on Triton (3), thus geochronologies must rely primarily on superposition relationships. The presumed earliest stage of Triton's history, the era of heavy cratering, has largely been erased. The oldest recognized surface on Triton is the cantaloupe terrain. The ridged and dimpled units grade into each other, so their relative ages are uncertain. The
dimples exhibit a range of preservation states, so they are among the last features to form on the formed on the unit. The cantaloupe terrain is superposed by all adjacent units, but its original extent is poorly constrained. If the bright rugged terrain is merely blanketed cantaloupe terrain, then the unit may have originally covered much of Triton's surface. The linear ridges are generally superposed on the cantaloupe terrain, though at least one dimple overlaps a ridge. The mottled hummocky terrain overlies the cantaloupe terrain at their single contact near the "Y" ridge, and buries the ridge itself to the east. The smooth dark terrain appears to overlie the hummocky terrain, though the contact is gradational. The association of the smooth unit with the ridge suggests a genetic relation. The relation between the hummocky materials and the patchy-smooth unit is indicated by a graben which crosses the former units but disappears in the patchy smooth materials. The smooth units to the north superpose the hummocky materials and at least some of the patchy smooth materials. The highland unit is the oldest of the smooth units, based on crater counts (the only relation so established). It is associated with the strings of rimless and rimmed irregular pits and represents a major phase of volcanic activity. The laminated terrain units are contiguous with and in part younger than the highland unit. The youngest of all is the valley smooth units on the floors of the "lakes". The knobby materials, which appear as collapsed sections of the smooth units formed sometime during the deposition of the smooth terrains. The dark spot materials also formed fairly late in this era. The bright polar units are the last form. The bright material of all polar units and the equatorial bar (not mapped) appears to mantle pre-existing units by varying thicknesses roughly correlated with the distance from the pole. The dark streaks, which lie on the bright materials. Unfortunately, an absolute age cannot be established. They may have been active in recent times. They may also be related to the extrusion of the indefinitely late dark lobate deposits to the north. The equatorial bar of bright material appears to overlie everything, and is thus the most recent feature.