N92-10911

STRATIGRAPHY OF THE PERRINE AND NUN SULCI QUADRANGLES (Jg-2 AND Jg-5), GANYMEDE.

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Dark and light terrain materials in the Perrine and Nun Sulci quadangles are divided into 9 map units, 4 dark and 5 light. These are placed in time-stratigraphic sequence primarily by means of embayment and cross-cutting relationships. Dark terrain is generally more heavily cratered and thus older than light terrain but, at least in these quadrangles, crater densities are not reliable indicators of relative ages among the 4 dark material units.

Dark Materials: The 4 mapped material units within dark terrain are: cratered dark materials (dc), grooved dark materials (dg), transitional dark materials (di), and dark materials, undivided (d).

The most widespread dark terrain unit consists of cratered dark materials (dc). Although the average albedo is relatively low, these materials have a patchy, streaked, or mottled appearance in detail because the surface is actually a montage of high and low albedo areas at km to 10's of km scale. In places, this appearance seems due to the presence of grooves or fragments of crater rims that are too small to map, but generally it is not possible to identify the surface characteristics responsible. The surface texture is rough at a scale similar to the albedo variations or smaller. Craters and palimpsests of all sizes from the limits of resolution to the largest present in the mapped area are superposed on this unit. These span the full range of crater ages present. Individual large grooves are present in places, many of which cross-cut or coincide with contacts between light and dark terrains.

Grooved dark materials (dg) occur generally as small areas adjacent to larger areas of cratered dark materials, commonly along contacts between the latter and light materials. The average albedo is somewhat higher than for cratered dark materials, and in detail the surface has a linear or streaked appearance consistent with the groove topography. The only large area of grooved dark materials occurs in the northern third of the large, sub-circular portion of Perrine Regio on Jg-2. Here the crater density appears to be less than in the southern two-thirds of this region, which is underlain by cratered dark materials. However, this impression is based on a grand total of 20 mapped craters and crater fragments, three in the northern third, 17 in the southern two-thirds, and thus should be only provisionally accepted as evidence for a real age difference. In many places, grooves in dark materials are clearly continuous with grooves in adjacent light materials, hence the grooves represent a relatively young structural modification of the dark materials. Grooved dark materials may thus be simply cratered dark materials that have been structurally modified, and older craters would logically be less recognizable where they are cut by grooves. Consequently, the apparent difference in crater ages between cratered and grooved dark materials is possibly unrelated to the true formation ages of the materials. The large area of grooved terrain mapped in Perrine Regio is included in the group of "system III" furrowed dark-terrain polygons by Murchie and Head (1988). We believe that the materials of this area are more correctly mapped as grooved than as furrowed because the troughs are morphologically similar to grooves, and not similar to furrows, and because at least some of them are continuous with typical grooves in the adjacent light terrain materials. However, the quality of the available images is so poor that it is not really possible to resolve this issue with any confidence.

Transitional dark materials (di) occur only in small patches adjacent to light materials. The distinguishing characteristic is an albedo intermediate between typical dark materials and typical light materials. Surface appearance may be similar to grooved dark materials or to dark materials, undivided. The intermediate albedo is presumably due to a smaller fraction of dark silicate(?) material near the surface than is the case for normal dark materials. The age relationships with cratered and grooved dark materials are unknown.

Dark materials, undivided (d) occur in small patches or in areas of very poor image resolution. Neither grooves nor craters can be resolved, and the surfaces generally appear to be smooth and of a uniform low albedo, an appearance most likely due to poor resolution in most instances. Undivided dark materials are inferred to be similar to either grooved or cratered dark materials.

Light Materials: The 5 mapped units within light terrain are: intermediate light materials (li), grooved light materials (lg), irregularly grooved light materials (lgi), smooth light materials (ls), and light materials, undivided. Intermediate light materials (li) are materials that are intermediate in albedo between other light materials (lg, lgi, ls, l) and the lightest dark material (di). Usage of this unit is restricted to a region in the northern portion of Jg-2. Texturally, this material appears similar to dark materials, but it is distinctly brighter than any of them. A possible explanation for the appearance of this unit is that the underlying material is in fact dark terrain that is blanketed by Ganymede's polar frost caps. These caps apparently are thin deposits of H_2O frost that cover the surface of Ganymede down to a latitude of 40^o–50^o in both hemispheres. They may be either the remnants of a formerly more extensive frost blanket that has been removed from lower latitudes by sublimation, or may be an accumulation of frost that has built up over time by transport from lower latitudes.

Grooved light materials (lg) are common, and are perhaps the most distinctive geologic unit on the satellite. Like irregularly grooved light and smooth light materials, they have a markedly lower crater density than is observed in dark terrains. Their distinguishing characteristic is the presence of very regular patterns of grooves transecting their surface. Grooves are curvilinear topographic depressions up to a few km wide, a few hundred m deep, and hundreds of km long. Grooves appear to be roughly U-shaped in cross-section, but unfortunately the resolution of the best images is insufficient to reveal the details of their geometry. Groove slopes are gentle; at Voyager resolution, typical slopes are less than 10^o (Squyres, 1981). The grooves are arranged in subparallel or fan-shaped sets that intersect and crosscut one another with geometry that can be very complex. The grooves in some sets are packed closely together, producing roughly sinusoidal topographic profiles, while in others they are widely separated, with distinct smooth areas between them. Where these smooth units become extensive, they are mapped as a distinct unit, ls.

Irregularly grooved light materials (lgi) are similar to grooved light materials in having low crater density, high albedo, and a surface dominated by grooves. The distinction is that the grooves are not arranged in sets. Instead, they can have a variety of complex geometries. Individual grooves may be straight, arcuate, or sinusoidal, but the trends of adjacent grooves are not correlated as they are in grooves that are arranged in sets. Individual grooves may crosscut and truncate one another, and it is not uncommon for grooves to split and merge at acute angles, forming a crudely anastomosing pattern.

The simplest light terrain is composed of smooth light materials (ls). These materials are similar in albedo to most other light terrains, but are distinguished by being free of grooves at the best available image resolution. Except for impact craters, topography is very subdued. In particular, no volcanic flows or other features that might provide morphologic clues to the emplacement mechanism are seen. Albedo is commonly fairly uniform across individual regions of smooth light material. Some regions, however, have a mottled appearance suggesting local variations in silicate content. Smooth light materials are seen in a variety of geometric relationships with other light units. Some occur as irregularly-shaped groove-free patches in areas that are otherwise dominated by a complex pattern of grooves. They also occur as long curvilinear swaths with geometry similar to groove sets. Some of these have bounding grooves. Smooth swaths and regions commonly have very sharp boundaries, both with other light units and with dark units. In other cases, however, the boundaries are indistinct and transitional to dark materials or to other light materials.

Undivided light materials (l) are simply materials that appear to have an albedo similar to those of other light terrains, but that are observed at an image resolution, viewing geometry, or illumination geometry that prevents recognizing characteristics that would identify them as belonging to one of the other mapped light units. They are mapped primarily in the poorly-imaged central portion of Jg-2.

Crater and Basin Materials: Crater and palimpsest materials are divided into 4 morphologic classes from highly degraded (palimpsests) to very fresh (bright ray craters). This classification is inferred to correspond approximately to a relative age sequence. Caution is necessary, however, because of size-dependent effects on degradation by micrometeorite bombardment, favoring survival of large craters, and size-dependent effects on degradation by viscous relaxation, favoring survival of small craters. Nevertheless, if very large and very small craters and palimpsests are ignored, one can infer with reasonable confidence that morphologically degraded craters are older than fresh craters.

References Cited:

Murchie, S.L., and Head, J.W., 1988, Possible breakup of dark terrain on Ganymede by large-scale shear faulting: Journal of Geophysical Research, vol. 93, p. 8795-8824.

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