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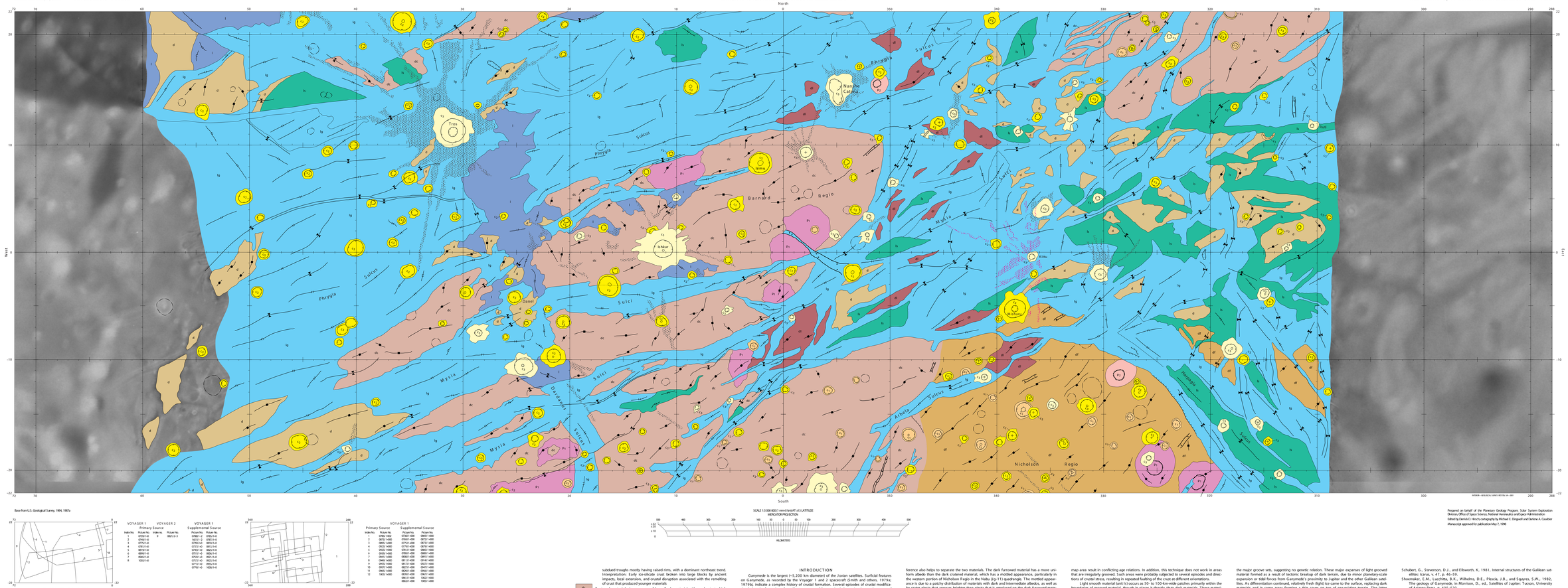
ATLAS OF JOVIAN SATELLITES: DARDANUS SULCUS (Jg-6), MISHARU (Jg-10), NABU (Jg-11),
AND NAMTAR (Jg-14) QUADRANGLES, GANYMEDE, SHEET 1 of 2



INDEX OF MAPPING FEATURES

The rendition of features on this map was controlled by reference to the primary source pictures outlined above. Supplemental source pictures were used where primary was lacking or listed separately. Copies of various enhancements of these pictures are available from National Space Science Data Center, Code 601, Goddard Space Flight Center, Greenbelt, MD 20771.

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GEOLOGIC MAPS OF THE DARDANUS SULCUS (Jg–6), MISHARU (Jg–10), NABU (Jg–11), AND NAMTAR (Jg–14) QUADRANGLES OF GANYMEDE

By
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INTRODUCTION

Ganymede is the largest (~5,200 km diameter) of the Jovian satellites. Surficial features on Ganymede, as recorded by the Voyager 1 and 2 spacecraft (Smith and others, 1979a; 1979b), indicate a complex history of crustal formation. Several episodes of crustal modification led to the formation of curvilinear systems of furrows in dark terrain, the emplacement of light materials, and the creation of impact craters in light terrain.

Prior to exploration of the Jovian system by spacecraft, Earth-based observations established that the surface of Ganymede is dominated by water ice with various admixtures of fine silicate (rock) material (Pilcher and others, 1972; Fill and Clark, 1982). No agreement yet exists as to the amount of water in the near surface material; early estimates based on spectral reflectance data suggested that half the surface was covered by nearly pure water ice, whereas later studies by Clark (1981) indicated that up to 95% of the surface could be water ice and still be consistent with spectroscopic data. The Pioneer encounters with the Jovian system in 1973 and 1974 revealed that Ganymede is composed of a mix of patches of light and dark terrain but did not have the spatial resolution needed to determine the percent cover of water ice, or geologic relations of surface materials. Not until the Voyager encounters was the surface seen with sufficient detail to enable geologic mapping.

On the basis of albedo contrasts, surface morphology, crater density, and superposition relations, geologic mapping was done using principles and techniques that have been applied to the Earth, Moon, and other terrestrial planets (Wilhelms, 1972). Considerable uncertainty exists in applying such methods to bodies having icy crusts, as the internal processes that produce their surface configurations are poorly understood, and the resolution of the Voyager images is barely sufficient to show the detail required to interpret structural and stratigraphic relations.

With the exception of the extreme southeastern portion of the Namtar quadrangle (Jg-14), all images used for mapping were taken by Voyager 1. At the time of encounter, the subsolar point on the Misharu (Jg-10) and Namtar quadrangles were near the terminator, making it difficult to distinguish albedo variations best seen at high sun angles. The western quadrangles were imaged at resolution for 2–5 km/pixel (Batson and others, 1983) from an oblique angle, so albedo variations can be seen, but topography and morphology are not well expressed in the images.

GEOLOGIC SETTING

The four mapped quadrangles are in the equatorial and southern regions of the Jupiter-facing hemisphere of Ganymede. Portions of the Dardanus Sulcus and Nabu quadrangles are on the leading hemisphere, and the Misharu and Namtar quadrangles are on the trailing hemisphere. This region of Ganymede is characterized by two major areas of dark materials, the southern part of Barnard Regio (centered near lat 1° N., long 1°) extends across the Dardanus Sulcus and Nabu quadrangles; Nicholson Regio (centered near lat 34° S., long 337°) forms the major dark unit in the Nabu and Namtar quadrangles. These two dark regions are separated by east-northeast-trending bands of light grooved material, the Mysia Sulci. Furrows in the dark materials have generally the same orientation as both the belts of grooved materials and the individual grooves within them.

Superposed on the grooved belts of light grooved materials (Phrygia Sulcus in Jg-6 and Mysia Sulci in Jg-11) are characterized by long sets of individual grooves that parallel the boundary of the material. Elsewhere, groove orientations are more irregular, as are the shapes of the patches of light material that contain them. In particular, the low sun angle images of the eastern parts of the Misharu and Namtar quadrangles accentuate irregularities in groove orientations, but also allow better delineation of smooth light material.

Elsewhere on Ganymede, large areas of grooved terrain have been interpreted as structurally deformed by large impacts early in this moon's history. No major impact structures have been identified in this region of Ganymede, but numerous smaller impact craters are present. The most notable fresh craters are Tros (lat 11° N., long 31°) with its extensive bright ray system, and Kittu (lat 1° N., long 337°), characterized by an asymmetric pattern of dark rays. Ghost craters, or palimpsests, located in dark terrain typically have little or no internal structure, whereas those that occur in light material commonly have subdued internal ring structures.

STRATIGRAPHY

Dark and light materials have been placed in time-stratigraphic sequence based on crater density, superposition, and embayment relationships. In addition to those factors, crater materials were classified based on their degree of preservation. In general, dark materials are more densely cratered and appear to have been subjected to light materials. However, craters with dark rays and floors occur in both types of materials, suggesting shallow stratification of light and dark materials rather than complete crustal replacement. Impact structures have been assigned to five age groups: two palimpsest material units and three crater material units.

DARK MATERIALS

The oldest geologic materials consist of dark cratered material (unit dc) and dark furrowed material (unit df), both of which occur in polygonal patches and lobate areas ranging in size from a few tens to many thousands of square kilometers. These materials form the major expanses of Barnard Regio (floored mostly by unit dc) and Nicholson Regio (floored mostly by unit df). These units display the maximum crater densities in the map area and have impact-related features of all ages, from scarcely visible palimpsests to fresh craters with extensive bright or dark ray systems. Both units have a greater abundance of old impact craters (d_2 craters) than other materials, but there is no obvious difference in crater density between the two dark materials. They are subdivided primarily by the density of furrows, but a subtle albedo difference also helps to separate the two materials. The dark furrowed material has a more uniform albedo than the dark cratered material, which has a mottled appearance, particularly in the western portion of Nicholson Regio in the Nabu (Jg-11) quadrangle. The mottled appearance is due to a patchy distribution of materials with dark and intermediate albedos, as well as by crater ejecta that appears brighter than ejecta that is emplaced on the dark furrowed material.

Both the large expanses of the cratered and furrowed materials and the smaller patches of these units that occur between light materials are characterized by furrows. In dark cratered material, furrows are more discontinuous and show less even spacing or less consistent orientation than those in the dark furrowed material. In the latter, large areas are transected by long, linear, subparallel furrows up to several hundreds of kilometers long and tens of kilometers wide. The furrows are spaced from 50 to 120 km apart and have raised rims, characteristics that distinguish them from grooves in light materials. Some are discontinuous and show a dominant northeasterly trend, particularly in Nicholson Regio, where they are most abundant. These furrows may have formed initially as grabens followed by modification of initial surface relief (Shoemaker and others, 1982) and are similar to grabens found in Galileo Regio (McKinnon and Melosh, 1980). The absence of any evidence for a large impact structure in the four quadrangles suggests that an early structural disruption was responsible for furrow formation rather than a crustal response to an ancient impact. Alternatively, an impact crater responsible for these structures could have been located well outside the map area.

Dark lineated material (unit dl) occurs as small slivers or irregular patches 50 to 100 km wide within or bordering areas of light grooved material (unit lg). Unit dl is characterized by subparallel lineations that in some cases are continuations of grooves in the surrounding grooved terrain and by a lower albedo than the neighboring light material. These materials likely consist of a mixture of silicate-rich (dark) and relatively clean (light) ice that has been tectonically disrupted by the same stresses responsible for the grooves in the neighboring light grooved material. Lucchitta and others (1992) suggested a similar origin for dark lineated and light grooved materials in the Memphis Facula (Jg-7) quadrangle. The small patches in the map area may have been arrested at the incipient stage of conversion from dark to light material.

Undivided dark material (unit d) has no specific surface morphology to enable subdivision into furrowed or cratered material units, occurs in patches too small to distinguish crater density, is obscured extensively by crater rays (for example, south of Nicholson Regio in the Namtar quadrangle), or is simply designated undivided because of inadequate image resolution, particularly in the western portions of the Dardanus Sulcus and Nabu quadrangles.

LIGHT MATERIALS

High albedo materials in the map area are subdivided based on the presence and density of grooves. Sets of grooves occur within broad, east-northeast-trending linear and arcuate bands (sulci) that transect dark materials, and within these sets are parallel and subparallel grooves up to 25 km wide and 1,000 km long. Crater density within the light grooved material (unit lg) is lower than that of dark materials, consistent with stratigraphic cross-cutting relations, indicating that light material formed later than and at the expense of dark material. Light materials also contain only a few old (unit c_1) craters and transect several of the oldest palimpsests (unit p_1).

Individual grooves are generally oriented parallel to the boundaries of the light grooved material. Most of the sulci are oriented east-northeast, but a notable exception is in the northern part of Dardanus Sulcus, which has a north-northeast orientation interrupted by an apparent right lateral offset at lat 18° S., long 18° (although no evidence for strike-slip faulting has been generally accepted on Ganymede). A nice sheet of grooved terrain have been interpreted as structurally deformed by large impacts early in this moon's history. No major impact structures have been identified in this region of Ganymede, but numerous smaller impact craters are present. The most notable fresh craters are Tros (lat 11° N., long 31°) with its extensive bright ray system, and Kittu (lat 1° N., long 337°), characterized by an asymmetric pattern of dark rays. Ghost craters, or palimpsests, located in dark terrain typically have little or no internal structure, whereas those that occur in light material commonly have subdued internal ring structures.

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