Fig. 1. Examples of light and dark terrains. The light terrain is pervasively cut by grooves and the dark terrain is cut by furrows. The furrows shown here belong to the dominant arcuate set in the anti-Jovian hemisphere. North is up. (Voyager 2 image 20635.37, centered near 25°N,210°W.)

scale grooved terrain emplacement for consistency with the observed patterns, and we propose a revised model. Third, we test the revised and previously proposed models by detailed geologic mapping of relative age units in select areas, and by measurement of crater density. Fourth, we attempt to relate local-scale tectonic patterns to global processes responsible for grooved terrain formation.

PROCEDURE

Detailed Geologic Mapping

To determine the local-scale stratigraphy of select areas of grooved terrain, we first compiled detailed geologic and structural maps of the areas using high-resolution Voyager images as base materials. Beginning with a completed geologic map, a new pair of maps was constructed. Of this new pair of maps, one map was of youngest groove sets superposed on all other groove sets, and the other map was of the remaining groove sets. Next, the latter map from this pair was used as a base, and a new pair of maps of youngest groove sets and of remaining groove sets was constructed. This process was repeated until superposition relations were no longer sufficient to determine relative ages of the remaining groove sets. Relative age units were compiled from the sequence of maps of youngest groove sets.

To use geologic mapping as a tool for determining relative age units of grooved terrain, conventions for interpretation of cross-cutting and superposition relations in grooved terrain must be established. Although these relations are complex, at least four general types are useful and can be interpreted with reasonable certainty, but perhaps not uniquely by all observers. The relations and interpretations are shown in Figure 3, and are: (1) relative ages of groove sets (Figures 3*a-g*), (2) relative ages of craters and grooves (Figures 3*h-j*), (3) recognition of flooding contemporaneous with groove formation (Figures 3*a*, 3*c*, 3*g*, 3*k-l*), and (4) identification of repeatedly reactivated zones of weakness (Figures 3*c*, 3*f*, 3*g*). In all of these examples in which relative ages of grooves are discussed, the ages are of surfaces and not of any underlying, reactivated structures. This distinction is critical, because in Figures 3*c*, 3*f*, and 3*g* surfaces of groove sets having a relative age younger than adjacent groove sets were formed by the reactivation of relict structures having an older relative age.

Cross-cutting relations of groove sets are characterized by superposition of one set on another or by termination of one set against another set. Figure 3*a* shows a younger groove, marked (2), superposed on older grooves, marked (1). The rationale for this interpretation is that the bands of light smooth material marginal to (2) and burying (1) are assumed to have been emplaced contemporaneously with (2) by flooding. This assumption is justified by the close associations of resurfacing and groove formation in general, and of marginal light smooth material with isolated groove sets crossing dark terrain. Narrow smooth deposits adjacent to groove bands are widespread globally, and therefore are useful in determining relative ages of groove sets. In Figure 3*b*, several short parallel grooves, marked (1), have an unclear age relation. Because of their proximity and parallelism, the grooves are assumed to have formed contemporaneously.

Figures 3*c–g* show several types of termination relations of groove sets. In Figure 3*c*, the grooves marked (1) are interpreted to be older than the groove band marked (2), because in the western part of the area (1) is interpreted to be buried by the smooth material marginal to (2). It is highly unlikely that the grooves in (1) simply failed to propagate to the margin of the groove band (2). In the eastern portion of the area, where the groove band (2) lacks marginal smooth deposits, the grooves in (1) occur immediately adjacent to the groove band. Because (2) also defines the lineament against which the grooves of (1) terminated in a "T-relationship," (2) must have formed by the reactivation of a throughgoing fracture zone older than (1). Figure 3*d* shows another younger groove set, marked (2), terminating against an older fracture, marked (1), whose apparent vertical offset laterally confined the emplacement of fluid light material. This site is an excellent example of the expected "T-relationship" of younger fractures terminating against an older one. In Figure 3*e* two groove sets, marked (2) and (3), terminate against an older groove band, marked (1). Groove sets (2) and (3) clearly are younger because the grooves themselves are superposed on (1). The smooth material marked (3') is marginal to the prominent grooves at (3), and is assumed to be contemporaneous because the grooves in (3) are not buried. However, the grooves marked (1') become progressively subdued as