MANIFESTATIONS OF STRIKE-SLIP FAULTING ON GANYMEDE. Lindsay C. DeRemer and Robert T. Pappalardo, Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder, CO 80309-0392 (deremer@vgr.colorado.edu).

Introduction: Voyager images of Ganymede suggested that strike-slip faulting may have taken place [1, 2], but the role of this process in shaping grooved terrain was uncertain. In Galileo high-resolution images of Ganymede's surface, we recognize three signature features of strike-slip faulting: (1) en echelon structures, (2) strike-slip duplexes, and (3) offset pre-existing features. We have undertaken a study to recognize and map these features, and identify any morphological progressions of strike-slip features. This will allow a better understanding of the structural history of Ganymede, and the formation and evolution of grooved terrain.

En Echelon Structures: En echelon structures (troughs and ridges) are expected in strike-slip shear zones. In model experiments, such features evolve with the magnitude of offset from en echelon Riedel shears to an anastomosing fault zone comprised of fault-bounded shear lenses [3].

En echelon zones have been recognized previously in some Galileo images [e.g. 4, 5]. We recognize en echelon zones in both dark terrain and grooved terrain. In dark terrain we find subparallel en echelon troughs that are isolated from one another (Fig. 1a), implying a small degree of strike-slip offset. Similar sets of en echelon troughs are present in grooved terrain and at some borders between grooved and dark terrain.

We also see en echelon fractures that are joined at their tips (Fig. 1b). These en echelon swaths enclose sigmoidal shaped blocks between fractures, suggestive of a somewhat larger degree of strike-slip offset. The apparent merging of the en echelon fractures at the tips is associated with bounding troughs on either side of the zone. In dark terrain, such en echelon swaths cross-cut the surface and appear more like traditional grooved terrain in comparison to the background dark terrain. Where they exist within grooved terrain, en echelon swaths (Fig. 1b) cross-cut the grooved terrain and are set apart by their en echelon internal structure. We infer that (as the strike-slip faulting progressed) en echelon fractures have merged together to define an en echelon swath and isolate this zone from the surrounding terrain.

Strike-slip Duplexes: Spindle-shaped lensoid regions bounded by strike-slip faults, or strike-slip "duplexes" [6], occur in dark terrain and are ubiquitous in the bright grooved terrain. An example in Uruk Sulcus (Fig. 2b) has been described by [4].

We identify and map several duplex and duplex-like structures, which we place into three categories based on fracture density and continuity of bounding faults, and on the presence of internal structure. (1) "Discontinuous fractures suggesting lensoid shape," which occur in dark terrain, are defined by discontinuous bounding structures of low fracture density, where no identifiable duplex-related internal structure exists. A duplex within dark terrain of the Galileo G2 Transitional Terrain observation (Fig. 2a) falls into this category. (2) "Lensoid bounding structures," also found in dark terrain, have fractures of great enough continuity and density as to define continuous lensoid-shaped bounding structures. These regions may or may not have identifiable duplex-related internal structure, but if present, it is not organized. (3) "Lensoid with subparallel internal structure," recognized in grooved terrain, exhibits continuous bounding structures and subparallel internal structures. The Uruk Sulcus duplex of Fig. 2b is the type example of this last category.

Strike-slip Offset: Displacement of pre-existing features can be evidence of major strike-slip faulting, even when other strike-slip zone structures are unidentifiable (as in low-resolution images). The type example of an offset feature is Dardanus Sulcus (Fig. 3) [2, 7]. The direction of offset indicates right-lateral strike-slip motion over ~150 km. We note that the fault zone on either side of Dardanus is relatively bright against the dark terrain.

Discussion: Manifestations of strike-slip faulting are ubiquitous on Ganymede, occurring in both dark and bright terrains. En echelon structures appear to be common. We infer that en echelon structures link together as the amount of offset increases, and that strike-slip zones in dark terrain may evolve into bright en echelon swaths with increased offset.

Fault duplexes also appear to be common. Mapping of duplexes and duplex-like structures suggests a sequence of events in their progressive development, in which originally discontinuous structures link together and then their interiors imbricate to form fault duplexes. This may be an evolutionary sequence involved in the transition from dark to bright grooved terrain. Finally, evidence of offset pre-existing features serves to further the case for common strike-slip deformation.

In some structurally complex regions, specifically Nicholson Regio (near Arbela Sulcus) and within Nun Sulci, these three elements of strike-slip faulting (en echelon zones, fault duplexes, and offset features), at various stages, are all inferred. Looking at structurally complex regions influenced by strike-slip faulting can provide clues to how strike-slip deformation has affected the surface of Ganymede. Strike-slip tectonism appears to be an integral part of the grooved terrain formation process.

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References: [1] B. Lucchitta (1980), *Icarus*, 44, 481-501. [2] S. Muchie and J. Head (1988), *JGR*, 93, 8795-8824. [3] M. A. Naylor et al. (1986), *J. Struct. Geol.*, 8, 737-752. [4] R. Pappalardo et al. (1998), *Icarus*, 135, 276-302. [5] G. C. Collins et al. (1998), *LPSC XXIX*, #1755. [6] N. Woodcock and M. Fischer (1986), *J. Struct. Geol.*, 10, 725-735. [7] B. A. Smith et al. (1979), *Science*, 204, 951-972.

Fig. 1. a) b)

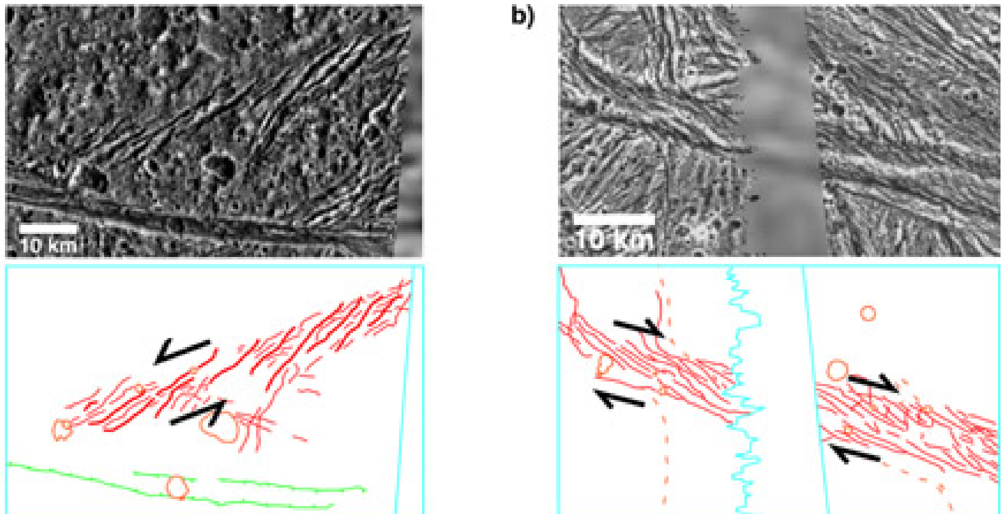

Fig. 2. a) b)

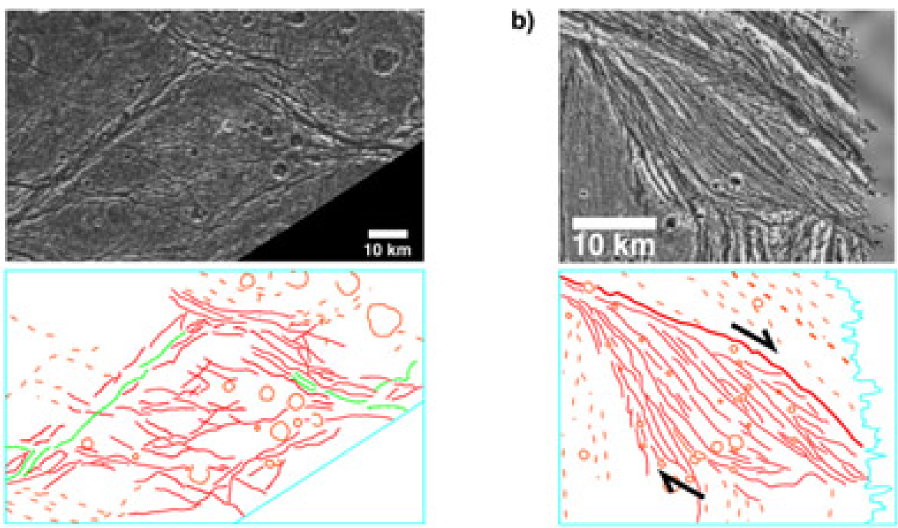

Fig. 3.

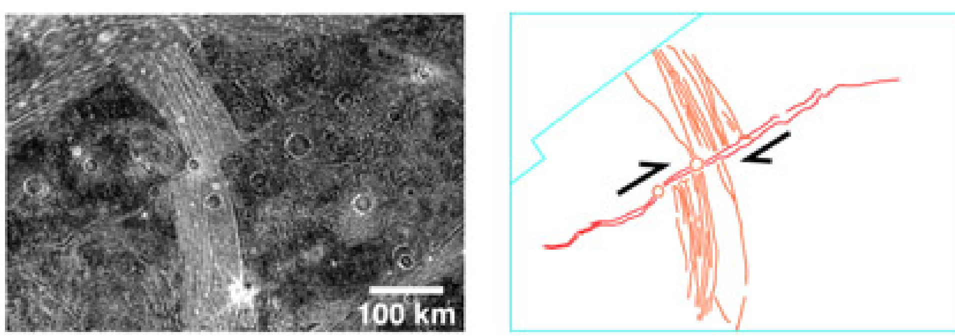

Fig. 1. Examples of en echelon structures: (a) in dark terrain (G8 Anshar Sulcus), (b) in bright grooved terrain (G1 Uruk Sulcus). On this and other figures, blue lines deliminate image boundaries, red outlines the features of interest, green indicates scarps, orange maps other features (craters and fractures outside the relevant zone), and black half-arrows indicate inferred shear sense.
Fig. 2. Duplex-like structures: (a) in dark terrain (G2 Transitional Terrain) illustrating "discontinuous fractures suggesting lensoid shape," (b) in bright terrain (G1 Uruk Sulcus) representing a "lensoid with subparallel internal structure."
Fig. 3. Dardanus Sulcus is the type example of a feature offset by strike-slip faulting.