MARIUS REGIO GROOVE LANE, GANYMEDE: NATURE OF DARK TERRAIN AND RELATIONSHIP TO GROOVE TERRAIN FORMATION. J. W. Head[1], R. Pappalardo[1], G. Collins[1], L. Prockter[1] C. Weitz[1], and the Galileo Imaging Team, [1]Dept. Geol. Sci., Brown University, Providence, RI 02912. (James_Head_III@Brown.edu)

Background and Rationale: This area is part of a complex set of groove lanes that intersect at the northern part of Marius Regio, a polygonal region of dark terrain in northern Ganymede (1). Voyager-based regional map units (1) in the target area consist of, in ascending stratigraphic order: Dark furrowed material (df): Light Material (Grooved material (lg); Smooth material (ls). Voyager data show that the targeted groove lane is perpendicular to the trend of the older, generally NE-trending groove lanes and polygons of Philus Sulcus, parts of Elam Sulcus, and smaller unnamed groove lanes within northern Marius Regio. The targeted groove lane trends NW and is parallel to Nippur Sulcus and Mashu Sulcus. The targeted region also lies at the confluence of several dark terrain furrow trends, at the intersection of a NW (younger) and ENE-trending (older) pair of groove lanes (1); it also has an unusual dark and bright-haloed C2 crater within the groove lane. Questions that were posed for this target site included: 1. What are the morphology of furrows and processes of formation and modification in the dark terrain? 2. What is the sequence of events in the dark terrain and how does it compare to other dark terrain areas? 3. What is the morphology of the grooved terrain lane and its grooves and the origin of regional patterns of groove orientation (e.g., the boundary and stratigraphy between the two groove sets?). 4. How was the light material in the grooved terrain lane emplaced? 5. What is the relationship between the dark terrain and the formation and evolution of the groove lane? 6. What are the characteristics of the unusual dark-bright haloed crater at high resolution? 1.7 frames forming 68 X 48 km mosaic at a resolution of 85 m/pixel was obtained (key observations are seen in Figure 1 at URL http://galileo.ivv.nasa.gov/sepo/atjup/ganymede/GG2GRVLNS.html).

Scientific Observations from the Galileo Data: Dark Terrain Craters: Craters greater than about a km in diameter in dark terrain range from morphologically fresh (but with no obvious ejecta) through moderately degraded (mostly by superposed cratering and tectonic fracturing) to highly degraded and often truncated. **Bright Terrain Craters:** The most striking crater in the bright terrain is the ~8 km diameter dark/bright halo crater located in the center of the groove lane. The larger crater interior is characterized by a polygonal rim crest, a dark floor, and a central bright peak area; the eastern part of the crater rim parallels the tectonic grain of the grooved terrain and at least one of the linear features may cut the crater wall and floor, and thus may be younger. The exterior is asymmetrical (elongated in an ENE direction) and composed of two parts: 1) an inner dark deposit that has a lobate margin; there is some evidence for multiple lobes within the dark deposit and the outer rampart of the lobate deposit is usually bright. This deposit is typically 3 km wide to the north and south, but extends ~5 km to the east and ~8 km to the west. Tongues and lobes of the dark deposit appear to be influenced by the presence of topography associated with the grooves in the groove lane, yet prominent ridges and grooves can be seen within the dark deposit suggesting that the emplacement processes did little to modify the morphology of the underlying grooves, or that some of the grooves may postdate the crater. Horner and Greeley (2) documented examples of lobate crater ejecta at Voyager resolution and interpreted them to be formed by ejecta flow, similar to many martian craters. 2) an outer bright unit that is generally asymmetrical (in a manner broadly similar to the inner dark deposit) and extends from 2-12 km from the edge of the inner deposit lobes; the unit has diffuse boundaries and is reminiscent of bright deposits surrounding other relatively young craters and composed of ejecta and locally excavated target material. The dark deposit/lobe radius to crater radius ranges from about 1.6-3, compared to dark halo radius to crater radius ratio of ~2.8 (3), and a pedestal radius to crater radius ratio of ~2.3 (2). If the dark halo represents excavation of dark material at depth (e.g., downdropped block of dark terrain, 3) implied depths to dark terrain are less than a km. Other options include projectile contamination, or some property related to the grain size or physical properties of the material emplaced in a 'fluidized' lobate mode.

Dark Terrain: Linear and discontinuous ridges and troughs (furrows): Furrows mapped in Voyager images are linear, curvilinear, or wavy troughs, 50 to several hundred km in length, 6-10 km wide and commonly have raised rims. In Voyager data of Marius Regio, several trends and degradation states of furrows are seen: the dominant set, named System I (4), are arcuate, forming a crudely concentric pattern with furrows spaced ~10-30 km apart, and trending N65-70E. This set may be related to an impact fracture origin (5) or extensional tectonics over a mantle upwelling (6). Superposed on the arcuate furrows are two additional sets: 1) single troughs 50-150 km long oriented approximately orthogonal to the arcuate furrows. 2) a set that crosscuts the arcuate set at oblique angles. In the Galileo data, these several trends and degradation states of furrows are observed much more clearly. The most distinctive furrow is 7-10 km wide, trends about N65-70E (similar to the System I trend), and terminates at the eastern edge of the orthogonally oriented groove lane. Part of its structure may continue on the eastern side of the groove lane. The furrow is formed by a relatively continuous pair of 1-3 km wide linear ridges which have been segmented by subsequent structural lineaments; the ridges range from symmetrical to asymmetrical in cross section, with the more extensive

side toward the interior floor of the furrow. The furrow interior has throughgoing parallel grooves and hills and is very different in appearance from the furrows seen in the Galileo Regio area. A second generally parallel furrow is seen to the north, but has been modified by subsequent impact. A third, highly degraded candidate furrow strikes about N80W, obliquely to the System I trends, and appears much more modified by subsequent structure. This furrow trend and that of the freshest furrow converge at the eastern margin of the groove lane in an area of considerable structural complexity at the westernmost margin of the eastern groove lane. Furrows in the dark terrain on the eastern side of the groove lane are less well-developed and distinct due to the presence of the eastern groove lane, and ejecta from a large crater. **Dark hummocky/polygonal terrain:** This terrain comprises the bulk of the dark terrain and ranges from hummocky to polygonal in shape and to can be relatively smooth in surface texture. Typically, hummocks are 1-3 km in width and formed from blocks dissected by structural lineaments of diverse orientations and from degraded crater rims and are of various shapes and commonly flat-topped to rounded in cross-section. Polygons are similar and their map geometry is dominated by cross-cutting structural trends. In some places, the surfaces of dark hummocky terrain are relatively smooth and polygons are typically larger. **Structures:** a) N30-40W-trending set of troughs and fractures; parallel to the margins of the bright grooved lane and the structures therein. The larger structures are interpreted to be graben; raised rims are not observed. The density of these features appears to be greater toward the groove lane and they may be related to the forces that were responsible for extension and lane formation. These are the youngest structures in the dark terrain with the exception of the complex transition zone. b) N65-70E trend, generally parallel to the System I furrows, largely fractures and grooves, with some ridges. In most cases these predate the N30-40W trend, but in some places they appear to be younger. c) Complex transition zone: In the dark terrain along the eastern margin of the groove lane is a structurally complex zone about 20 km wide that is the western extension of the eastern groove lane mapped at Voyager resolution; the eastern groove lane has been mapped (1) as extending to, and being cut by, the NW-trending groove lane. At Galileo resolution, the relationships are much more complex. Graben and fractures in the dark terrain along the eastern margin of the NW-trending groove lane are cut by oblique faults (shear?) and these oblique faults become progressively more important to the south in this zone until they become the dominant feature in the middle of the zone. In this transitional area, there are two lines of evidence of shear: 1) small parallel ridges oriented obliquely to the major trends; 2) a large trough that changes orientation and becomes a ridge. The overall configuration of these suggest that transtension with a right-lateral shear component may be operating. In the easternmost part of this zone, the texture is dominantly parallel ridges and troughs and is very similar to the ridges and troughs in groove lanes. Further east, at Voyager resolution, this area appears to be a typical groove lane. **Bright Terrain:** The bright grooved lane trending N30-40W consists of a family of parallel grooves a few hundred meters wide and spaced a few hundred meters apart dominantly trending parallel to the strike of the groove lane; several generations of 'stripes' appear within the groove lane and the most prominent and apparently the youngest is 7 km wide located near the middle of the groove lane. Parallel ridges and troughs give way to oblique and anastomosing ones in the central part of the target area, coincident with the extension of the most well-developed furrow and the location of the complex transition zone. Much of the area between the grooves and ridges in the groove lane appears relatively smooth; this is additional evidence for cryovolcanic resurfacing, as suggested for the nearby Nippur Sulcus area. The margins of the groove lane are often formed by a bounding trough which appears to be part of the dark terrain graben system.

Preliminary Conclusions: 1. System I arcuate furrows are morphologically freshest and oblique furrows more degraded; the NW-SE groove lane location appears to be controlled by the furrow set orthogonal to system I and the NE-SW groove lane trend related to the convergence of two groove sets. Impacts and tectonic segmentation are key processes in furrow modification. 2. At Galileo resolution, dark terrain is heterogeneous and is dominated by furrows, a wide range of tectonic structure, and impact craters; definitive evidence for volcanism is not seen. 3. Grooves appear subdued compared to Uruk and much of Nippur Sulcus and smooth areas may be cryovolcanically flooded; groove orientations appear controlled by preexisting furrow structure and the NW-SE groove lane is confirmed as youngest of the two. The dark haloed crater shows evidence of both proximal lobate and distal ballistic emplacement; if the dark material is excavated from below it implies that the bright groove lane is less than a km deep.

References: 1. S. Murchie and J. Head, 1989, USGS Misc. Geol. Investigation, Map I-1966; 2. V. Horner and R. Greeley, 1982, Icarus, 51, 549; 3. P. Schenk and W. McKinnon, 1985, JGR, 90, C775; 4. S. Murchie and J. Head, 1986, GRL, 13, 345; 5. E. Shoemaker et al., 1982, Satellites of Jupiter, 485; 6. R. Cassachia and R. Strom, 1984, JGR, 89, B419.