Fig. 11. Morphologically and stratigraphically distinctive dark terrain trough in southern Galileo Regio. North is up. (Voyager 2 image 20637.08, centered near 18°N,158°W.)

unique, postfurrow dark terrain trough segments, and (3) linearity to the only two long system II structures that terminate against lineament I between areas 1 and 2 or 3.

Two plausible examples of shear offset of grooved terrain structures, both left-lateral in sense, occur between areas 1 and 3 along lineament I. These are shown in Figures 8 and 14 at the locations marked "A" and "B," respectively, in Figure 7*b*. First, two short groove lanes southeast of Galileo Regio ("A" and "B" in Figure 8) either may have undergone 75 km of left-lateral offset or may have occupied a previously offset structure. The surrounding dark reticulate terrain has been pervasively deformed since furrow formation, as is discussed shortly. Second, two elongate blocks of dark reticulate terrain, located immediately south of Galileo Regio (Figure 14), appear to be fragments of a larger block that were offset left-laterally by 15 km. The small magnitudes of these latter offsets suggests that either (1) they are the result of distributed shear between areas 1 and 3, or (2) they occurred subsequently to most shear motions.

Central-southern Marius Regio boundary. Two major structures exhibit offsets across lineament III and are consistent with minor right-lateral shear having occurred. The first structure is the throughgoing, north-northeast oriented dark terrain trough in central Marius Regio (Figure 12 - at the location marked "C" in Figure 7*b*). The trough exhibits about 40 km of right-lateral offset across two or more narrow, closely spaced groove lanes that may occupy older strike-slip faults. A linear structure that may represent one of these faults is seen at the location marked "A" in Figure 8*b*. A southward, counterclockwise shift in the trough's orientation may have predated offset or may be the result of shear deformation; in the latter case, total offset may approach 100 km. The second structure, shown in Figure 15 (located at "F" in Figure 7*b*), is a narrow, curvilinear groove lane 150 km east of Tiamat Sulcus that has been offset about 40 km in a right-lateral sense.

Origin of offset structures. An alternative model for the origin of offset-appearing structures, suggested by *Shoemaker et al.* [1982], is that such structures formed in situ. Major offsets of throughgoing structures on Ganymede are extremely uncommon, and those discussed above are the largest observed in the anti-Jovian hemisphere. If the apparent offsets formed in situ, then two conditions must be met. First, only by chance were the structures truncated by lineaments I and III, across which there is independent evidence for shear. Second, only by chance do the structures have senses of offset matching those implied by the independent evidence. A more straightforward assumption is that the structures were originally continuous and were disrupted by shear.

Block Rotation and Deformation in Proposed Shear Zones

The lithosphere of Ganymede may be described as large blocks of furrowed dark terrain, separated by smaller, generally deformed blocks. Shear offsets of the large blocks are hypothesized here to have disrupted an originally more concentric set of arcuate furrows; within any shear zones, it is reasonable that rotation or internal deformation of the smaller lithospheric blocks may have occurred.

Galileo Regio-Marius Regio boundary. In the earlier analysis of the morphologies of lineaments I and II it was suggested that there may be a wide zone of distributed shear between areas 1 and 3, including area 2, Elam Sulci, Uruk Sulcus, and surrounding small dark blocks. Within this wide zone, possible block rotations were identified in two locations. One location is the whole of area 2 (northern Marius Regio, Figures 2 and 7*b*), which consists of a mosaic of dark terrain blocks several hundred kilometers in size that are separated by narrow groove lanes. It was suggested earlier that the large separation of the furrow pole of area 2 to the northwest of the pole of area 3 may have resulted in part from minor block rotations that altered the local radius of furrow curvature. To test this hypothesis, possible block rotations were retrodeformed by removing hypothesized extension (several to 50%) of the narrow groove lanes. For larger amounts of retrodeformed strain, the fit of area 2 arcuate furrows to small circles centered on the pole of area 3 was found to be improved. The retrodeformed groove lanes, as well as most others between areas 1 and 3 ("F" in Figure 2*b*), have east-west to east-southeast orientations expected for transtensional features if area 2 is within a wide zone of distributed, left-lateral shear. In addition, the stratigraphically oldest of the retrodeformed groove lanes are wedge-shaped and taper to the west suggesting counterclockwise block rotation (arrows, Figure 2*b*), the sense expected in a left-lateral shear zone.

Another site between areas 1 and 3 where rotation may have occurred is southeast of Galileo Regio, at the location shown in Figure 8, where groove lane segments "A" and "B" may be offset across a curvilinear fracture zone. Segment "B," to the south, is more northwest oriented, consistent with rotation either of it or of a preexisting zone of weakness in the counterclockwise sense that is expected for left-lateral shear.