STEREO TOPOGRAPHY OF VALHALLA AND GILGAMESH:

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The geology and morphology of the large multiring impact structures Valhalla and Gilgamesh has been used to infer ways in which the interior structure and properties of the large icy satellites Callisto and Ganymede differ from rocky bodies [1,2]. These earlier studies were made in the absence of topographic data showing the depths of large impact basins and the degree to which relief has been preserved at large and small scales. Using Voyager stereo images of these basins, we have constructed the first detailed topographic maps of these large basins. These maps reveal the absence of deep topographic depressions, but show that multi-kilometer relief is preserved near the center of Valhalla.

Digital Elevation Models (DEM) of these basins were produced using an automated digital stereogrammetry program developed at LPI for use with Voyager and Viking images. Galileo will provide no topographic data for these satellites except for extremely small areas. The Voyager images used here were obtained from distances of 80,000 to 125,000 km. As a result, the formal vertical resolution for both Valhalla and Gilgamesh maps is ~0.5 km. Relative elevations only are mapped as no global topographic datum exists for the Galilean satellites. In addition, the stereo image models were used to remap the geology and structure of these multiring basins in detail.

VALHALLA

The 4000-km-wide Valhalla basin consists of several dozen closely spaced rings: V-shaped ridges and troughs in the central zone, and graben or outward-facing scarps in the outer zone. The relief across these ridges ranges from 2 to 3 km from crest to trough. The deepest relief is associated with ridges at a radius of 425 to 450 km, approximately the location of the crater rim proposed by [3] on the basis of ejecta mapping. These ridges dominate Valhalla topographically. With a few exceptions, ridge crests lie at about the same topographic elevation. There is no indication of a central depression. The central 600-km-wide palimpsest has less relief than the ridge zone, as expected, but is not smooth. The palimpsest has a mean relative elevation somewhat higher than the mean elevation within the adjacent inner ridge zone. The elevation of the palimpsest is not higher than the crests of adjacent ridges, however, consistent with the observation that some ridge crests protrude above the palimpsest.

GILGAMESH

Gilgamesh consists of 3 topographic rings, with radii of ~115, ~290, and ~470 km. Relief across the middle ring (corresponding to the location of the structural rim) is ~1 km, with some knobs up to 2 km high. Relief across the inner ring is ~900 meters on its outer flank, but is ~1.5 km on the inner flank descending to the 150-km-wide central depression. This inner ring corresponds to a discontinuous structural ring of unusually large massifs, and is interepted as the large-scale equivalent of a central pit rim or peak ring. Relief across the outer ring is ~1 km. The central depression is bowed convex upward by ~500 meters.

DISCUSSION

The topographic structure of Gilgamesh confirms the impression that this 580-km-wide basin has morphologic elements similar to basins on silicate planets [2]. The ~1.5 km relief across Gilgamesh is very shallow compared to lunar basins, however, despite the relative youth of this basin. The bowed topography of the central depression may be indicative of viscous relaxation. The shallow depth is also very similar to depths of central pit and central dome craters only 100-150 km across. This supports the contention that the interior of Ganymede cannot support significant topographic relief at any scale.

The vertical and horizontal dimensions across ridges and scarps within Valhalla can now be used to make realistic estimates of strain and deformation resulting from ring formation. These estimates can then be used to place additional constraints on ring formation models [e.g., 1, 4]. Relief of up to 3 km across individual structures occurs within the nominally older Valhalla basin on Callisto, despite the apparent absence of any significant long-wavelength topographic expression. This suggests that the ancient lithosphere of Callisto has been capable of supporting substantial relief over time. This is significantly more relief than is preserved on large impact structures of similar age on Ganymede and suggests that Callisto had somewhat different rheologic properties (stiffer and stronger) than Ganymede over time.

REFERENCES: [1] McKinnon, W. and H. Melosh, Icarus, 44, 454, 1980. [2] Passey, Q. and E. Shoemaker, Satellites of Jupiter, 1982. [3] Schenk, P., J. Geophys. Res., 1996. [4] Melosh, H., J. Geophys. Res., 87, 1880, 1982.

Fig. 1. Topographic profiles across Valhalla and Gilgamesh. Profiles begin in center and extend radially outward. Valhalla palimpsest extends from 0 to ~200 km in this profile. Bowed topography of center of Gilgamesh is not shown in this profile. Profile hints that Gilgamesh rings may be asymmetric. Profiles have been smoothed, and have errors of +/-500 m.