GALILEO VIEWS OF THREE MAJOR MULTI-RING FEATURES ON CALLISTO.
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Introduction
The surface of Callisto, the second largest satellite of Jupiter, is characterized by extensive impact cratering and several large multi-ring systems. The three largest multi-ring systems, previously imaged by Voyager at best resolutions of 4 to 5 km/pixel -- Valhalla (~4000 km in diameter), Asgard (1640 km in diameter) and Adlinda (~850 km in diameter) -- were imaged by the Galileo spacecraft at resolutions ranging from 0.035 to 17 km/pixel (Figure 1). Galileo gave the first detailed look at Adlinda, having been poorly imaged by Voyager as it was heading over the limb. With the improved resolutions came new structural interpretations for the various structural zones of the multi-ring features, such as the occurrence of ridges, not scarps, within the scarp zone of Asgard, and the possibility that the troughs within the trough zone of Valhalla are actually a series of outward-facing rotated fault blocks.

Background
Analysis of Voyager images of Callisto’s multi-ring systems identified the major structural zones of these features: an interior bright plains unit, generally lacking in structural elements, and concentric structural zones which varied in type at each multi-ring system. Valhalla’s structural zones included an inner ridge zone, a trough zone, and an outward-facing scarp zone found only in the northeastern part of the system [1-5]. Asgard’s two zones were an inward-facing scarp zone sur-rounded by a graben/trough zone [1]. Voyager images of Adlinda did not allow for identification of individual features’ structural types [1].

Data and Analysis
Galileo images now provide more detailed views of the individual structural features present in these multi-ring systems. Regional and high resolution images within the Valhalla system reveal a surface less cratered than anti-cipated, and as discussed below, containing a differing variety of structural elements within individual zones than was postulated from Voyager data. The overall surface texture appears to reflect mass wasting as well as other processes of surface disaggregation that allow for volatile loss and the development of a dark “lag” surface. Trough features imaged at 0.40 km/pixel first appear to be mainly v-shaped in profile, and exhibit terracing rather than the anticipated graben form. Further study indicates that these features might be outward-facing down-dropped blocks, with some possible rotation indicative of listric-shaped fault planes, or possibly grabens whose easternmost walls are at a lower elevation than their western counterparts. In many instances, small sinuous ridge type features, ranging in length from 20 to 60 km, bound one or both sides of the “trough” type features. These ridge features may represent zones of weakness within the surface material where continued fracturing and/or faulting could occur. Valhalla’s scarp zone, whose scarp heights range from 200 to 300 meters, also contains small sinuous ridges (approximately 35 to 55 km long) which parallel the outward-facing scarps. However, unlike trough zone ridges, these ridges occur on the down-dropped side of the scarp features.

Galileo images of Asgard show a less distinct transition from scarp zone to trough zone than at Valhalla, with a more gradual change occurring from inward stepping scarps to trough features. The interior of some of the outermost troughs of Asgard also have inward-facing, possibly rotated fault blocks. The central bright plains unit of Asgard owes a component of its higher albedo to a young dome crater located on its southwestern margin. The large size of the central dome of this crater, 27 km wide, may be related to its impact within the central region of the multi-ring system and could provide information about the relative strength and mobility of the material that forms the interior plains of the Asgard system. The morphology of scarp zone features is that of discontinuous sinuous/arcuate ridges, not scarps. There is no associated fault scarp seen with the ridge features, and slopes occur off of both sides of the medial ridge form. High resolution im-ages of the trough zone (0.102 km/pixel) show no apparent fault boundaries, indicating that these features are not graben but paired ridges with interven-ing, possibly talus-containing areas. In some cases the area between ridges appears to be infilled with talus.

Both positive and negative relief features are seen in the first regional resolution images of Adlinda (0.877 km/pixel). The features include discontinuous arcuate ridges, graben, and fractures. Many of Adlinda’s structural features are obscured by ejecta from the young rayed crater Lofn, located approximately 500 km southeast of the center of the multi-ring system. Typical spacings of structural features within Adlinda range from a few tens to 100 km. The longest and most continuous feature is an approximately 800 km long arcuate graben, which appears to bifurcate as it reaches its southeastern terminus. It is possible that there was mech-anical as well as thermal alteration of the structure of Adlinda due to the formation of the 125 km crater Lofn, possibly involving enhanced disaggregation or volatile loss.
Future Work

The presence of a large central dome crater within Asgard and the lack of dome craters at Valhalla and Adlinda could be informative about the relative strength and mobility of material forming Callisto’s subsurface. By applying past basin formation models [2,6] to observed morphologies, we can test whether an ice-rich surface layer is thinner at Asgard than Valhalla. Continued consideration of ring features will also address the issue of spatial or temporal variations in layer thickness.

References


Figure 1. Location map of Callisto’s 3 major multi-ring features: Asgard (32.0°N, 139.8°W), Valhalla (15.9°N, 56.6°W), and Adlinda (56.6°N, 23.1°W).