

**TOPOGRAPHIC MAPPING OF IO FROM VOYAGER AND GALILEO STEREO IMAGES: MOUNTAINS, CALDERAS, AND VOLCANOES, OH MY!** R. R. Wilson<sup>1</sup> and P. M. Schenk<sup>2</sup>, <sup>1</sup>Lunar and Planetary Institute, Houston, TX 77058 (rwilson@lpi.usra.edu), <sup>2</sup>Lunar and Planetary Institute, Houston, TX 77058 (schenk@lpi.usra.edu).

**Introduction:** Regional topographic mapping of volcanically active Io covering at least 75% of the surface has been completed (Fig. 1). Digital elevation models (DEMs) were derived from stereo image coverage obtained by the Voyager-1 and Galileo spacecraft (through orbit I25). Spatial resolution of the stereo pairs used ranges from 100 to 2000 m/pixels. Vertical precision (equivalent to contour interval) is highly variable across the surface, ranging from 250 to >2000 meters. These data provide a wealth of geophysical constraints on the formation and evolution of mountain, caldera, and volcanoes on Io.

**Topographic Mapping:** *Coverage.* Stereo coverage of Io is highly variable due to the different Voyager and Galileo flyby geometries (Fig. 1). Coverage includes regional views extending nearly to the poles to high-resolution targeted views of specific features. Low-resolution stereo images are of interest for mapping the relief of large-scale features such as shield volcanoes, and for mapping topography over large areas (including C21-I24), complimenting limb topography [1]. Galileo stereo coverage is concentrated in the anti-jovian hemisphere (e.g., Colchis Regio), Voyager coverage in the sub-jovian hemisphere. Approx. 75% of the surface can be nominally mapped at 2 km vertical resolution or better. Mapping better than 1 km vertical resolution is concentrated between 305°W and 360°W, and between 110°W and 195°W. Stereo data are lacking in polar regions north of 60°N and for portions of the south polar region.

*Technique.* Io is perhaps the most difficult solar system body to map topographically using stereo DTM techniques. DTM generation on Io is based on automated photogrammetry [2,3], and is complicated by the severe and continually changing photometric behavior of the Ionian surface. The phase changes and time lags required for stereo on Io are often accompanied by contrast reversals and morphologic changes for different terrains and units, especially diffuse deposits. Finally the use of different filters also produced undesirable contrast reversals due to different spectral properties. Finally, the ubiquitous volcanic plains that cover much of Io are often featureless at 500-2000 m/pxl resolution, the typical image resolution used in these stereopairs. These properties complicate the ability of the stereo matching routine to lock in on features and derive parallax. As a result, a significant percentage of the nominal mapping area does not contain valid to-

pographic data. To partially compensate, a technique employing multiple looks using variable DTM spot sizes in our autocorrelation package was used to maximize data recovery. In this report we present initial science results from these mapping efforts.

**Mountains:** Although they cover only 3% of the surface of Io, the 115 or so mountains are of great interest because of their apparent non-volcanic origin. Topographic results for mountains have been reported elsewhere [4]. They find that the heights of mountains range from ~1 to 11 km, averaging 6 km. Roughly ten of these mountains stand 10 or more kilometers above the plains, with the highest, Boosaule Montes, reaching  $17.5 \pm 3$  km altitude. Many of these mountains appear to be tilted or upthrust crustal blocks [4,5]. If so, these heights support the concept of a relative thick crust on Io at least 15 and probably more than 20 km thick.

**Paterae:** Paterae, most of which probably represent volcanic calderas, are among the most common features on Io. Voyager based analysis indicated that at least a few calderas had steep walls and depths of 1-2 km [6], indicating the crust is probably not dominantly sulfur in composition. Our data reveal numerous additional deep calderas but also show that many calderas have little or no relief relative to surrounding plains. Further analysis is in progress and will be reported.

**Volcanoes:** The topography of volcanoes is important for understanding the physical volcanology of ionian lavas. In preliminary topographic work, Schenk et al [2] reported that the 500-km wide Ra Patera flow field is a shield-like volcano less than 2 km high, with slopes of less than  $0.5^\circ$ . We report measurements for other volcanoes on Io and preliminary analysis suggests that most volcanoes mapped in our study areas have similar characteristics, including low heights and shallow slopes. This suggests that high-temperature ultramafic Ionian lavas [7] may also be low-viscosity.

**References:** [1] Thomas, P., et al. (1998) *Icarus* **135**, 175-180. [2] Schenk, P. M. et al. (1997) *Geophys. Res. Lett.* **24**, 2567-2470. [3] Schenk, P. M. and Bulmer M. H. (1998) *Science* **279**, 1514-1516. [4] Schenk, P. M. et al. (submitted 2000) *J. Geophys. Res.*; Schenk, P., et al. (2000) *B.A.A.S.* **32**, 1046. [5] Carr, M., et al. (1998) *Icarus* **135**, 146-165. [6] Clow, G., and Carr, M. (1980) *Icarus* **44**, 268-279. [7] McEwen, A. S. et al. (1998) *Science* **281**, 87-90.

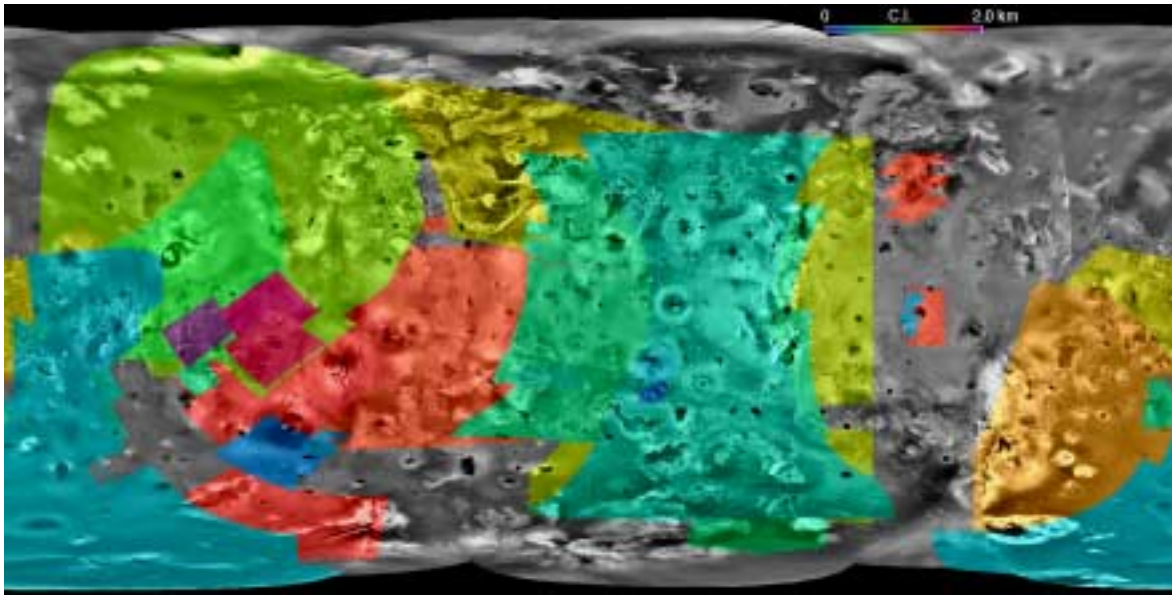


Figure 1. Preliminary stereo image coverage map of Io (including up to GLL orbit I-25). Global cylindrical map shows the distribution of stereo images color-coded to represent predicted vertical height precision (equivalent to contour interval) expected from automated stereo matching routines. Blue represents best data, reds represents worst.