HIGH RESOLUTION DIGITAL TERRAIN MODELS OF ASTEROID IDA: A COMPARISON BETWEEN PHOTOGRAMMETRY AND THE SHAPE-FROM-SHADING METHOD; B. Giese[1], J. Oberst[1], R. L. Kirk[2], and W. Zeitler[1], [1]DLR, Institute of Planetary Exploration, Rudower Chaussee 5, D-12489 Berlin, Germany, [2]U.S. Geological Survey, 2255 N. Gemini Drive, Flagstaff, AZ 86001.

Abstract. The asteroid Ida was imaged by the SSI camera during the second Galileo asteroid flyby in August 1993. We derived high resolution digital terrain models in selected regions of Ida based upon a rigorous photogrammetric analysis and compared these results with terrain models derived from a two-dimensional photoclinometric ("shape-from-shading") analysis. Our comparison shows that there are striking discrepancies between the two models depending on spatial scales of surface features. This suggests that surface morphology studies of the asteroid should not rely on just one of these models.

Methods. The *photogrammetric analysis* comprised the following steps (i) adjustment of the orientation parameters of high resolution images in a common bundle block adjustment. This included 36 images and 95 image points [1]. (ii) determination of conjugate image points in two or more images using a least-squares matching algorithm (iii) computation of ground point coordinates (x,y,z) from conjugate image point coordinates and adjusted image orientation parameters by photogrammetric forward intersection. In contrast, the method of *two-dimensional photoclinometry* is based upon the reconstruction of the surface topography from shading information in a single image. The object distance of the spacecraft, the Sun position, the photometric properties of the surface, and some surface roughness function must be known. Also, a starting topographic model is needed. The set of equations is solved by iteration [2]. To describe surface photometric properties, a combination of the Lommel-Seeliger and the Lambert photometric functions was adopted [3], parameters of which were determined by fitting observed brightness values in images to those of synthetic images that were computed based on a global shape model of Ida [4].

First Results and Discussion. A photogrammetric terrain model was computed using Galileo stereo images S0202562339 and S0202562000 (bottom of Figure). The pixel resolutions are 37 m and 59 m, respectively, and the accuracy of the resulting object points is about 20 m. This was compared with a shape-from-shading model which was derived from image S0202562339. At first sight the topographies resulting from photoclinometry and photogrammetry look very similar. However, a quantitative comparison shows that significant discrepancies exist between the two models in surface regions with low and, especially, high spatial frequencies. High spatial frequencies: resolution in photogrammetry is limited because of (i) the limited accuracy of the object point coordinates and (ii) the large patch size (7 pixels) over which the least-squares matching was carried out. Results from photoclinometry are expected to be correct within the assumptions taken. Low spatial frequencies: here, photogrammetry is most reliable while photoclinometry may fail because of bad convergence of the iterations. As there is some interest in the morphology of impact craters [5], we determined depths and diameters for two craters (top of the Figure) from the two models (Table 1). Crater I is a crater with medium spatial frequencies so there is agreement to some extent. In contrast, crater II has mostly low spatial frequencies and photoclinometry failed but the results from photogrammetry appear trustworthy.

Table 1

crater I / crater II	photogrammetry	photoclinometry
depth [m]	116 / 250	107 / 140
diameter [m]	905 / 2430	1185 / 2400

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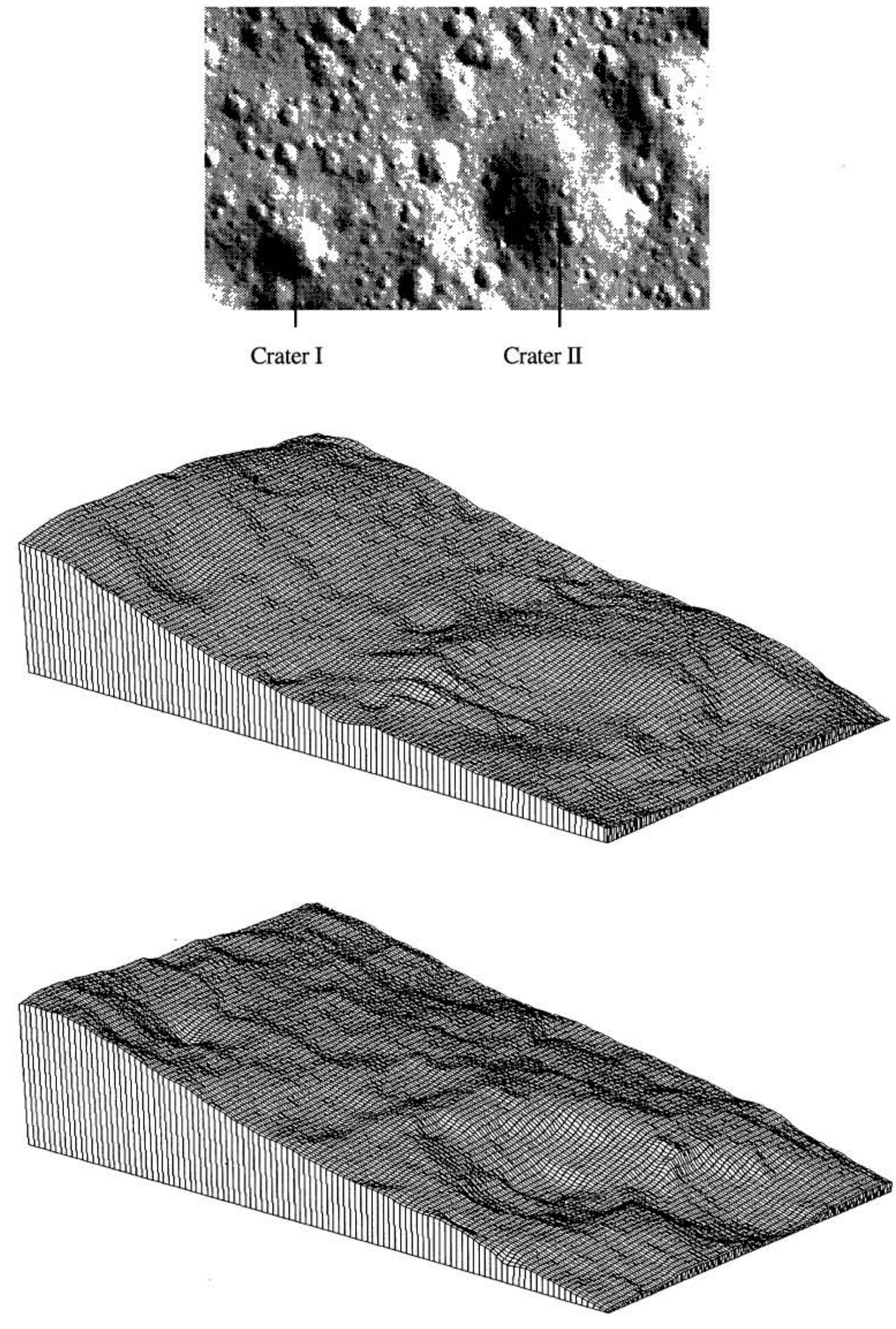

Figure: Part of Ida image S0202562339 (top), topography from clinometry (center), and stereo (bottom)

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