TOPOGRAPHIC FEATURES OF ITHACA CHASMA, TETHYS. B. Giese[1], R. Wagner[1], G. Neukum[2], P. Helfenstein[3], and C. C. Porco[4]. [1]German Aerospace Center, Institute of Planetary Research, Rutherfordstr. 2, 12489 Berlin, Germany, bernd.giese@dlr.de; [2]Institut für Geologische Wissenschaften, Freie Universität, 12249 Berlin, Germany; [3]Department of Astronomy, Cornell University, Space Sciences Building, Ithaca, NY 14853, USA, [4]Cassini Imaging Central Laboratory for Operations, Space Science Institute, 4750 Walnut Street, Suite 205, Boulder, CO 80301, USA.

Introduction: Ithaca Chasma is the most prominent tectonic feature on Tethys (R~530 km). It was first seen in Voyager I images as an enormous valley about 1000 km long and 50 to 100 km wide [1]. The origin of this rift valley is not clear yet. Smith et al. (1981) [1] suggested that Ithaca Chasma was formed by freeze-expansion of Tethys' interior but other models relate Ithaca Chasma to the formation of the 400 km Odysseus impact basin (a comprehensive overview of formational models is given in [2]).

Photoclinometry was applied to infer the topography of Ithaca Chasma [1]. An average depth of ~3km was obtained and a raised rim of ~ 0.5 km above its surroundings was found. However, low image resolutions (Voyager I: 15 km/lp at best, Voyager II: 5 km/lp at best) have prevented in-depth morphologic studies. In this paper we report on the topography of Ithaca Chasma derived from high resolution Cassini-stereo images.

Observations: For the stereo modeling of Tethys we used images from Cassini's 4th and 15th orbit with resolutions in the range of 500-150 m/pxl. Fig. 1 shows a mosaic of 400 m/pxl images.

Terrain modeling: Two Digital Elevation Models (DEMs) were derived using methods of photogrammetry [4]. The horizontal resolution of the models is 2-5 km and vertical accuracies range from 400-800 m and 150-300 m, respectively. As a reference for elevations an ellipsoid was considered. A mosaic of the DEMs is shown in Fig. 1.

Topographic features: Fig. 1 shows that the chasma has two branches in the southern section and just a single branche north thereof. The southern branches are narrower than the single branch and triangle-shaped (Fig. 2, p4, p5). The profiles (Fig. 2) reveal that the chasma is 2-3 km deep with respect to the surroundings confirming the earlier Voyager result from photoclinometry. There are sub-parallel ridges and troughs inside forming terraces at the walls. The scarps are edged. The most striking feature of the chasma is the upraised flank topography that is elevated up to 6 km above the surroundings. Flank-uplift extends over about 60 km across strike direction. The southern section has upraised topography in-between the branches. Ithaca Chasma cuts a 330 km peak ring basin (Fig. 1) at its western rim section. This basin was not recognized at Voyager times but was recently discovered in the Voyager images [5]. The inner ring diameter is half of the outer rim-to-rim diameter in agreement with findings for the terrestrial planets. The outer crater rim is rounded and heavily degraded and the floor is level with the surroundings.

Implications: *(i)* The observation of a peak ring basin on Tethys seems to be unique but new Cassini data suggest that Odysseus may also possess an inner ring. *(ii)* Cut by Ithaca Chasma, the peak ring basin is definitely older. The topographic data suggest that it is also older than Odysseus because Odysseus has sharper rim sections and much more rim-to-floor relief of 6-9 km [2]. *(iii)* Models relating the formation of Ithaca Chasma to the Odysseus impact are challenged. As the basin is almost as large as Odysseus a feature similar in size to Ithaca Chasma should have formed by the impact if such models apply. But this is not observed.

Upraised flank topography is typical for rifts on Earth and was also found for rifts on the icy surface of Ganymede [6]. The obtained topographic profiles across Ithaca Chasma can be used to estimate the effective elastic thickness of the lithosphere. This is an important parameter to estimate the heat flux at the time of formation. Here, we apply the model of a broken elastic plate [7]. The best fit between the model and the observations was obtained at an elastic thickness of ~ 5 km (Figs. 2, 3).

Ages: Crater size-frequency measurements inside Ithaca Chasma and outside confirm previous Voyager-based measurements [3]. Our measurements show that frequencies inside the chasma are about 1.5-2 times lower than outside. This implies that the chasma is about 100-200 My younger in a lunar-like impact chronology [8]. The frequencies in the peak ring basin are about the same as outside of Ithaca Chasma.

References: [1] Smith B. A. et al. (1981) *Science, 212,* 163-191. [2] Moore et al. (2004) *Icarus, 171,* 421-443. [3] Plescia J. B. and Boyce J. M. (1985) *JGR, 90,* 2029–2037. [4] Giese B. et al. (1998) *Icarus, 135,* 303-316. [5] Stooke P. J. (2002) *LPSC XXXIII,* 1553–1554. [6] Nimmo et al. (2002) *GRL, 29(7),* 1158, 10.1029/2001GL013976. [7] Turcotte D. L. and Schubert G., *Geodynamics,* Cambridge Univ. Press, 2002. [8] Neukum G. et al. (2006) *EGU abstract,* submitted.

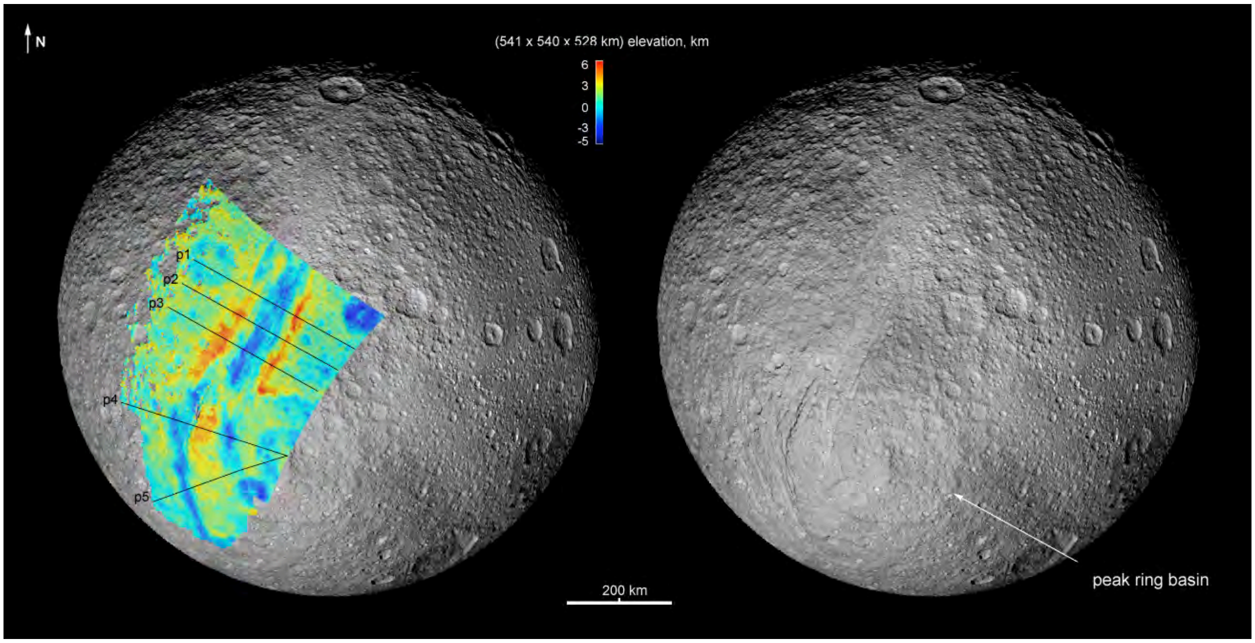

Fig. 1: Color-coded DEM derived from Cassini-stereo images, superimposed on 400 m/pxl image mosaic centered at 2°S, 16°E. The DEM reveals large rift flank uplift at Ithaca Chasma and an old 330 km relaxed peak ring basin.

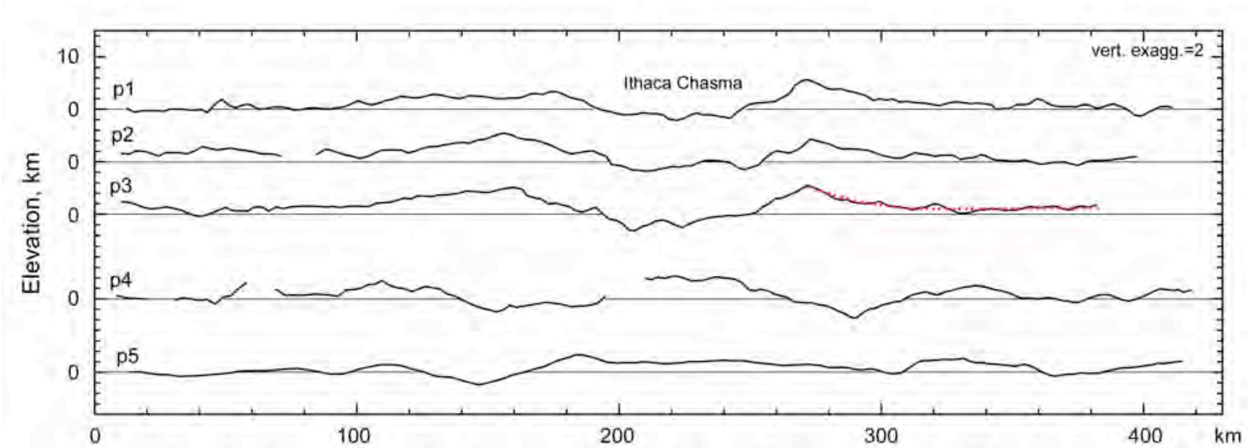

Fig. 2: Elevation profiles across Ithaca Chasma (location is shown in Fig. 1). The dotted red line is the best fit flexural profile obtained by modeling the lithosphere as a broken elastic plate.

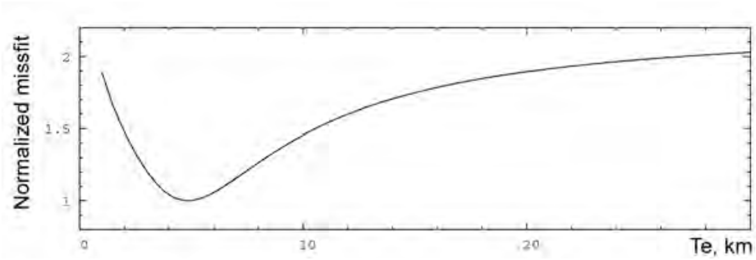

Fig. 3: Misfit between the model function (Fig. 2, red line) and the elevation data in dependence on the elastic thickness of the lithosphere Te. The best fit is obtained at Te ~ 5 km at a Young's modulus of 1 GPa (Te ~ 3 km at 5 GPa).