GEOLOGY AND STRATIGRAPHY OF SATURN'S SATELLITE DIONE OBSERVED BY THE CASSINI ISS CAMERA. R. Wagner (1), G. Neukum (2), T. Denk (2), B. Giese (1), T. Roatsch (1), and the Cassini ISS Team. (1) Institute of Planetary Research, German Aerospace Center (DLR), D-12489 Berlin, Germany (E-mail: Roland.Wagner@dlr.de) , (2) Institute of Geosciences, Freie Universitaet Berlin, D-12249 Berlin, Germany.

Introduction: Over two decades ago, the cameras aboard the two Voyager spacecraft imaged Saturn's satellite Dione (1124 km in diameter) at spatial resolutions of at least 1 km/pxl. Its surface is characterized by (1) cratered plains with varying crater frequencies and ages, (2) smooth plains which were believed to be volcanic extrusions of an H_2O-NH_3 eutectic melt, and (3) tectonic features such as scarps, troughs and ridges [1][2][3]. These features which are indicative of extension as well as compression were believed to be a consequence of episodes of global expansion and contraction through time [3][4]. The trailing hemisphere, imaged only at low resolution (> 5 km/pxl) by Voyager, shows a system of very bright, filament-like linear markings termed *wispy material* [2]. It was interpreted as a surficial deposit associated with volcanic exhalations along cracks [1][2].

Image data base: Since the Cassini Orbiter has been inserted into an excentric orbit around Saturn on July 1, 2004, image data at resolutions between 1.4 km/pxl and 430 m/pxl were obtained by Cassini ISS (Narrow (NAC) and Wide Angle Cameras (WAC)) in two non-targeted flybys (Dec. 2004 and June 2005). Areas not very well covered by Voyager were imaged in these encounters showing more or less unknown terrain in much better detail (e.g. *Fig. 1*).

Main topics and procedure: The basic questions addressed in this study are: **(1)** What are the **geologic units** seen in the areas imaged by Cassini ISS, what is their **stratigraphic sequence**, and how do they compare to the units mapped on Voyager data ? **(2)** What are the **ages** of these units, obtained from *crater size-frequency measurements* and from application of *impact chronology models* ? Is there a *Crater Population I* & *II* as has been suggested [1] ? **(3)** Is there evidence for past **cryovolcanic activity** ? **(4)** What is the nature of the ***wispy terrain*** on the trailing hemisphere ? Ages are assigned by means of impact cratering chronology models. Two such models are currently used: (a) *Model I* with a lunar-like (exponential) decay in impact cratering with time (Late Heavy Bombardment (LHB)), and with a more or less constant cratering rate since about 3 b.y. (billion years) [5][6][7], and (b) *Model II* with a constant cratering throughout most of solar system history [8].

Results: (1) Heavily cratered plains are the spatially most extensive and oldest units on Dione, confirming Voyager results [1][2][3]. Degraded tectonic features indicate early episodes of tectonism. Unexpectedly, there are no old, degraded impact basins as seen on other icy satellites, such as Rhea, Iapetus, or the Galilean satellite Callisto [9][10][11]. Model ages of this oldest unit are either higher than 4 b.y. (*Model I*) or higher than 2.5 b.y. (*Model II*). **(2)** Resurfacing has been caused by ***tectonism*** rather than by cryovolcanism. There is no evidence for flows or pyroclastic deposits on Cassini ISS data so far. **(3)** Also, the wispy material has been shown to be of tectonic rather than of cryovolcanic origin. Light ist scattered from numerous fault scarps. Several episodes of extensional tectonism (with an unknown contribution of shear) can be recognized. According to crater size-frequency measurements and model ages, tectonic episodes may date back to > 3.7 b.y. (*Model I*) or > 1 b.y. (*Model II*). **(4)** Less densely cratered plains in many cases are associated with younger craters, basin(s) and their ejecta. Since there are stratigraphically younger large craters, there is no conclusive evidence for two different crater populations I (heliocentric projectiles during LHB creating craters > 20 km in diameter) and II (smaller, post-LHB Saturno-centric projectiles) as suggested by [1]. **(4)** Only one (unnamed) basin with a diameter of about 400 km was discovered so far (see *Figs. 1, 2*). This basin is stratigraphically young. Model ages are on the order of ~3.2 b.y. (*Model I*) or only ~0.33 b.y. (*Model II*). **(5)** The youngest units on satellite surfaces are generally associated with bright ray craters. Such features have not yet been observed on Dione. One feature named Cassandra was presumed to be a ray crater but turned out to be actually a set of radial scarps radiating away from a point source, exposing bright ice on the scarp slopes.

Future work: Upcoming targeted flybys during the Cassini Mission (one targeted flyby will take place on Oct. 11, 2005) will provide extensive high-resolution and stereo image coverage which will help to investigate small-scale surface details and tectonic landforms. Also, a comparative investigation of Dione and its outer neighbour satellite Rhea is of importance since Rhea also shows wispy markings on its surface which could not be seen in detail so far. These features most likely also originate from tectonic stress rather than from cryovlcanism.

References: [1] Smith, B. et al. (1981), *Science 212*, 163-191. [2] Plescia, J. (1983), *Icarus 56*, 255-277. [3] Moore, J. (1984), *Icarus 59*, 205-220. [4] Consolmagno, G. (1985), *Icarus 65*, 401-413. [5] Boyce, J. & Plescia, J. (1985), in: *Ices in the Solar System* (D. Reidel Publ.), p. 791-804. [6] Neukum, G.

(1985), *Adv. Space Res*. 5, 107-116. [7] Neukum, G. et al., *LPSC XXXVI*, abstr. No. 2034 (CD-Rom).

References (continued): [8] Zahnle, K. et al. (2003), *Icarus 163*, 263-289. [9] Wagner, R. et al., *LPSC XXXV*, abstr. No. 1964 (CD-Rom). [10] Moore, J. et al. (2004), *Icarus 171*, 421-443. [11] Giese, B. et al. (2005), *Bull. Am. Astron. Soc. 37*, abstr. No. 47.08, p. 728.

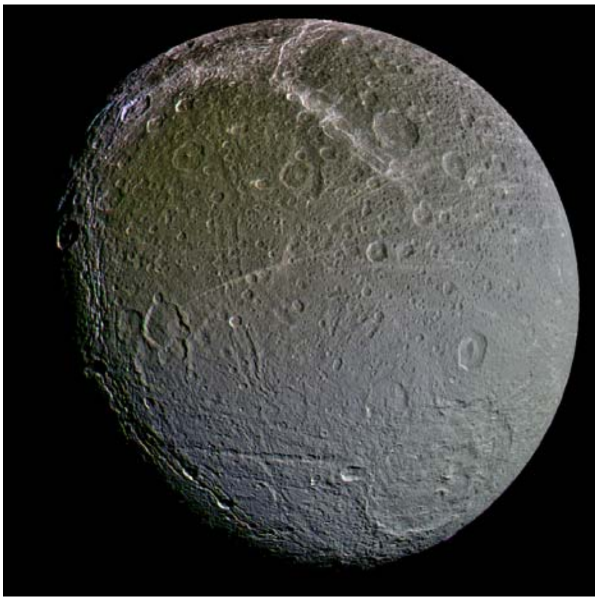

Fig. 1: Part of the trailing and southern hemisphere of Dione. Image shows cratered plains, degraded craters, tectonic features, and a large basin near the south pole with a diameter of 400 km. The south pole is located to the west of the basin. The single trough going from top to bottom approximately follows the 270° (West) longitude. False-color representation using the hue-saturation-intensity color transformation.

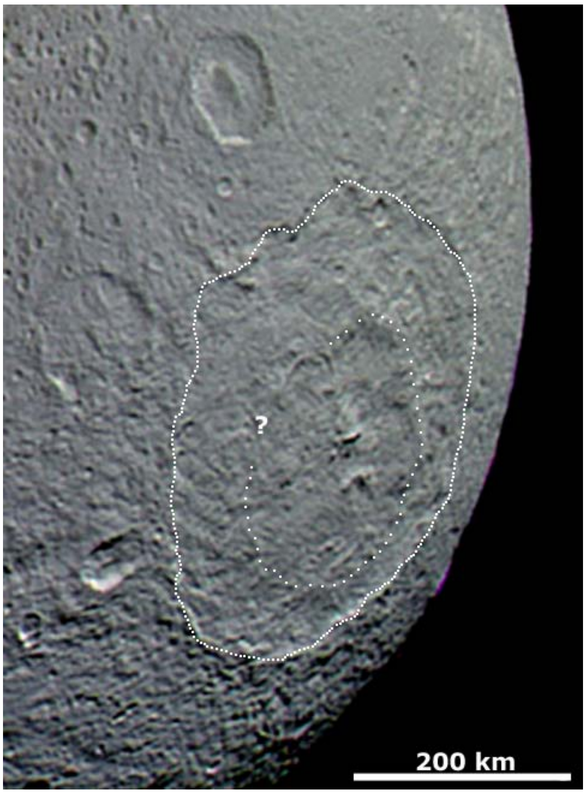

Fig. 2: Detailed view of the unnamed basin in the south polar region. The basin possibly has two rings, but the inner ring is very poorly seen.