THE GLOBAL GEOLOGY OF RHEA: PRELIMINARY IMPLICATIONS FROM THE CASSINI ISS DATA.

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Introduction: With a mean diameter of 1528 km [1], Rhea is the second-largest satellite of Saturn. Its average density of 1.233 gcm^{-3} [1] implies a more or less icy body with smaller amounts of heavier elements. The surface of Rhea is dominated by water ice, inferred from a high geometric albedo of 0.65 and from the presence of water absorption bands [e.g. 2].

Geology of Rhea prior to Cassini: At a maximum spatial resolution of 500 m/pxl, Rhea was the best one imaged of the saturnian satellites. Voyager-1 images showed a densely cratered leading hemisphere, while the trailing hemisphere, seen only at very low resolution, was characterized by bright, filament-like wispy markings, similar to those on Rhea's inner neighbor Dione [3]. The densely cratered terrain was subdivided into three to six units by different investigators, based on crater abundance, texture and the presence of lineations [4][5]. Up to three large multi-ring structures were identified [4]. Tectonic features observed are troughs, scarps, ridges (of minor abundance), and lineaments [4][5][6].

Image data base: Up to now, Cassini has completed 35 revolutions around Saturn. Rhea was imaged by the Cassini Narrow Angle (NAC) and Wide Angle cameras (WAC) during several non-targeted flybys at resolutions better than 1 km/pxl (in flybys 00C, 005, 016, 020, 022, 027), with the highest resolutions (better than 10 m/pxl) achieved so far in flyby 018 (Nov. 2005).

Procedure: The work presented in this paper is the continuation of our investigations carried out on Rhea's inner neighbor Dione [7] whose geologic features are comparable to those on Rhea. (1) Geologic units are mapped and compared to the units mapped in Voyager data. (2) Ages of these units are obtained from *crater size-frequency measurements* and from application of *impact chronology models*. Ages are assigned by means of impact cratering chronology models: (a) *Model I* with a lunar-like (exponential) decay in cratering rate with time and with a more or less constant cratering rate since about 3 b.y. (billion years) [8][9][10], and (b) *Model II* with a constant cratering rate throughout most of solar system history [11].

Results: At regional scale (500 -1000 m/pxl), the densely cratered plains on Rhea show little variation in terms of albedo and morphology. Lineations observed in one unit by [4] appear to be characteristic features of the cratered plains. Despite the high density of craters, measured crater frequencies show production distributions. Average cratering model ages in the cratered plains are on the order of 4.2 Gyr (Model I, [10]) or 3.6 Gyr (Model II, [11]). Variations in large-crater abundances discussed by [4][5][12] can be confirmed. Areas deficient in large craters are found on the trailing hemisphere preferentially. Smoother areas with a paucity of smaller craters are also observed but lack clear evidence for cryovolcanic resurfacing, or mantling by airfall deposits discussed by [5].

Basins and large craters. Large craters and multi-ring structures are abundant. The anti-saturnian hemisphere is characterized by two basins, 400 to 500 km in diameter. One of these two basins, Tirawa (basin "A" in [4]), has a slightly elliptic outline. From examination of low-sun Voyager images, two rings were reported by [4] but ISS data show an elongated central peak complex instead. The elliptic shape and the elongated central peak complex infer an oblique impact. Tirawa overlaps another, larger and more degraded basin to its southwest. While a lower crater density and hence a younger age was reported for Tirawa [4], our crater counts show that crater frequencies inside these two basins are comparable to the frequencies outside hence both basins are old features on the order of 4 Gyr. A large but very degraded basin in the sub-saturnian hemisphere ("B" in [4]) could not have been confirmed so far in ISS data, but stereo analysis suggests the presence of at least another basin ("C" in [4]; see below subsection *tectonic features* and *Fig. 1*). Large craters (or proto-basins) with diameters > 200 km are also abundant across Rhea's surface.

Ray craters. While stratigraphically young, bright ray craters characterize the surfaces of the icy satellites of Jupiter, they are not common on the saturnian satellites. Only one prominent ray crater is found on Rhea, located at lat. 12.5° S, long. 112° W. The bright rays of the 48-km crater show a butterfly wing pattern implying an oblique impact from the east. Using the frequency of superimposed small craters in the continuous ejecta measured on a high-resolution WAC image (34 m/pxl resolution), model ages for this ray crater are either 2.5 Gyr (Model I, [10]), or only 70 Myr (Model II, [11]).

Tectonic features. Like Dione, Rhea was known for its bright filament-like so-called *wispy streaks* which were observed only at low Voyager resolution on both satellites [3]. On Dione, the tectonic nature of these streaks and various tectonic episodes that created these structures could by verified by Cassini ISS data [7]. On Rhea, Cassini ISS data also revealed the tectonic nature of these structures. A part of the trailing hemisphere covering these *wispy streaks* is shown in an anaglyph image (*Fig. 1*). While troughs and ridges found in various locations on Rhea infer preferentially extensional and (minor) compressional tectonism [4][6], the en-echelon pattern of the scarps and troughs on the trailing hemisphere indicates shear stress. These structures, which have an orientation of about North-South extend further southward into a more NE-SW direction through crater Leza and may reflect a so-called megascarp indicating a degraded basin rim (basin "C") discussed in [4]. The presence of this basin is also inferred from the lower topography of the region east of the en-echelon structures (around crater Heller).

Work in progress: Large craters and basins as well as major tectonic features will be assigned names on near-term [e.g. 13] in order to facilitate stratigraphic work (e.g. in establishing rock-stratigraphic group and formation names). Also, our current work is focused on extending the crater size-frequency data base as well as the derivation of digital elevation models of selected areas in order to gain topographic data.

References: [1] Thomas P. C. et al. (2006), *LPSC XXXVII,* abstr. No. 1639. [2] Clark R. N. et al. (1986), in *Saturn*, UofA Press, Tucson, Az., p. 437-491. [3] Smith et al. (1981), *Science 212,* 163-191. [4] Moore J. M. et al. (1985), *JGR 90 (suppl.),* C785-C795. [5] Plescia J. B. (1985), *NASA-TM 87563*, 585-587. [6] Thomas P. G. (1987), *Icarus 74*, 554-567. [7] Wagner R. et al. (2006), *LPSC XXXVII*, abstr. No. 1805. [8] Boyce J. & Plescia J. (1985), in: *Ices in the Solar System* (D. Reidel Publ.), p. 791-804. [9] Neukum G. (1985), *Adv. Space Res*. 5, 107-116. [10] Neukum G. et al. (2005), *LPSC XXXVI*, abstr. No. 2034. [11] Zahnle K. et al. (2003), *Icarus 163*, 263-289. [12] Lissauer J. J. et al. (1988), *JGR 93*, No. B11, 13,776-13,804. [13] Roatsch T. et al. (2006), *Planet. Space Sci. 54*, 1137-1145.

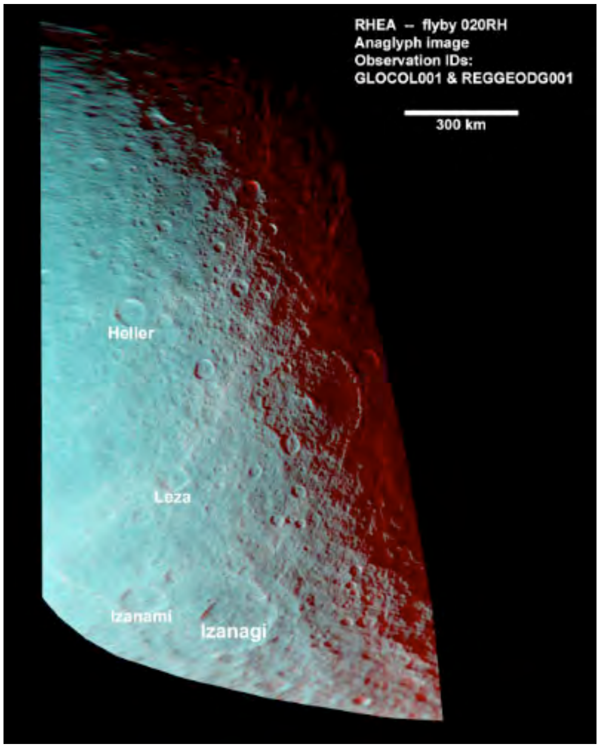

Figure 1: Anaglyph image of part of the trailing hemisphere of Rhea (equidistant projection). Data from flyby 020RH (Jan. 2006). Average spatial resolution of the data is approximately 1 km/pxl.