DISTRIBUTION OF ICY PARTICLES ACROSS ENCELADUS' SURFACE. R. Jaumann[1], K. Stephan[1], R. Wagner[1], G. B. Hansen[2,] R.H. Brown[3], K. H. Baines [4], G. Bellucci [5], J.-P. Bibring [6], B. J. Buratti [4], F. Capaccioni [7], P. Cerroni [7], R. N. Clark [8], M. Combes [9], A. Coradini [7], D. P. Cruikshank [10], P. Drossart [9], G. Filacchione [7], V. Formisano [5], C. A. Hibbitts [2], Y. Langevin [6], D. L. Matson [4], T. B. McCord [2], Mennella, Vito [11]; R. M. Nelson [4], P. D. Nicholson [12], B. Sicardy [9] and C. Sotin [13], [1] DLR, Inst. for Planet. Expl. Rutherfordstrasse 2, 12489 Berlin, Germany; [2] Planetary Science Institute, 22 Fiddler's Rd., Winthrop WA 98862-0667; [3] Dept. Pl. Sci and LPL, U. of AZ, Tucson AZ 85721-0092; [4] Jet propulsion Laboratory, Pasadena CA 91109; [5] Istituto Fisica Spazio Interplanetario, CNR, Via Fosso del Cavaliere, Roma , Italy; [6] Universite de Paris Sud-Orsay, IAS, 91405 Orsay Cedex, France; [7] Institutio di Astrophisica Spaziale, Via Fosso Del Cavaliere, Roma, Italy; [8] USGS, Mail Stop 964, Box 25046, Denver Federal Center, Denver CO; [9] Observatoire de Paris-Meudon, Dept. de Recherche Spatial, 5 Pl. Jules Jannsen, 92195 Meudon Principal Cedex, France; [10] NASA Ames Research Center, Astrophysics Branch, Moffett Field, CA 94035-1000; [11] Institutio Nazionale di Astrofisica, Osservatorio Astronomico di Capodimonte, Via Moiariello 16, Napoli, Italy; [12] Cornell University, 418 Space Sci. Bldg, Ithaca, NY 14853; [13] U. of Nantes, B.P. 92208, 2 rue de la Houssinière, 44072 Nantes Cedex 3, France (ralf.jaumann@dlr.de).

Introduction: Compositionally, the surface of Enceladus is build up almost completely by water ice [1]. However, distinct variations in the size of water ice particles are apparent. As the band depths of water ice absorptions are sensitive to particle size, given constant abundance and viewing geometry, absorption depths can be used to map these variations across the surface.

The Visual and Infrared Mapping Spectrometer [2] observed Enceladus with high spatial resolution during two Cassini fly-bys in 2005 (orbit 4 and 11). Based on these data we measured the band depths of water ice absorptions at 1.04, 1.25, 1.5 and 2µm. The same procedure was applied to a water ice model developed by G. B. Hansen (PSI), which represents theoretically calculated reflectance spectra for a range of particle sizes between 1µm and 1mm [3].

Results: Figure 1 and 2 show the measured band depths at 1.04 versus 1.25µm, and 1.5 versus 2.0µm compared to the values obtained from the water ice model. The good agreement between the experimental (VIMS) and model values supports the assumption that almost pure water ice characterizes the surface of Enceladus and thus that variation in band depth correspond to variations of particle size within a given observation. According to the comparison with the model values the particle sizes of water ice vary between ~0.002 and ~0.1mm. Specific particle sizes vary slightly between the two measurements. This may be the result of low signal-to-noise ratio for the case of the two shallow absorptions at 1.04 and 1.25µm.

In either case, three distinct spectral units can be separated exhibiting different particle sizes which are strongly correlated to surface features. Figures 3 and 4 show a comparison between the classifications of particle sizes and geological maps of the regions observed during the two fly-bys 4 and 11. Both observations include regions between 150 and 280°W, which enclose mainly the trailing hemisphere. However, in contrast to orbit 4 which observed more or less the equatorial region of Enceladus, VIMS data of orbit 11 reach into a region farther south including the South Pole of the moon.

Our measurements show that the particle size of water ice increases toward younger regions with the largest ones in "fresh" surface material. The smallest particles were generally found in old more or less densely cratered plains and the larger ones in younger tectonically resurfaced areas (e.g. the sulci = ridged and grooved bands) [4]. The largest particles (>0.02mm) are concentrated in the so called "tiger stripes" of the south polar area [1,5]. The averaged reflectance spectra for these classes (Fig. 5) support these models. The reflectance spectrum of the cratered terrain fits very well between the water ice spectra of 0.005 and 0.01 mm. However, the spectrum of the "tiger stripes" resembles water ice with particles larger than 0.02mm.

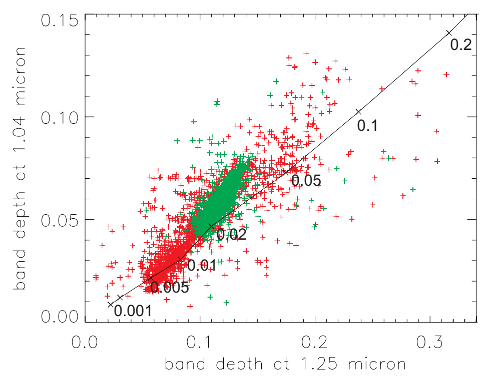

Fig. 1: Measured band depths of water ice absorptions for Enceladus at 1.25 versus 1.04µm compared to band depths of the water ice models.

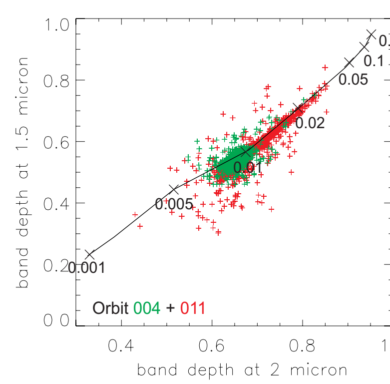

Fig. 2: Measured band depths of water ice absorptions for Enceladus at 1.5 and 1.25µm compared to band depths of the water ice models.

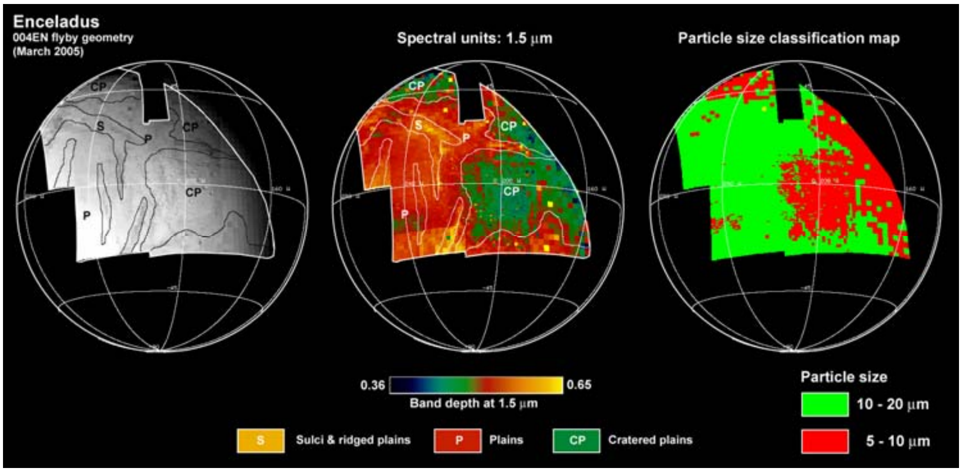

Fig. 3: Enceladus mosaic based on VIMS data acquired during orbit 4: (left) geological map based on the spectral channel at 2µm; (center) band depth at 1.5µm and (right) particle size classification.

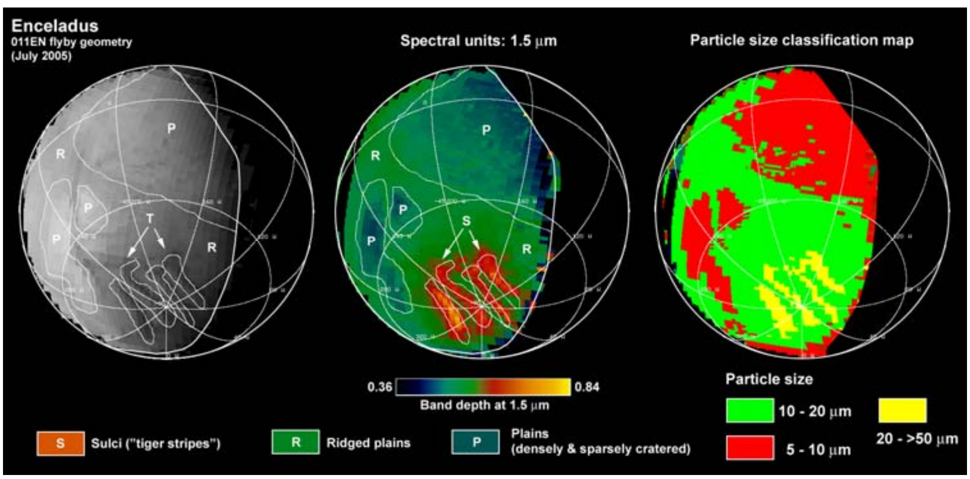

Fig. 4: Enceladus mosaic based on VIMS data during orbit 11 including the South Pole: (left) geological map based on the spectral channel at 2µm; (center) band depth at 1.5µm and (right) particle size classification.

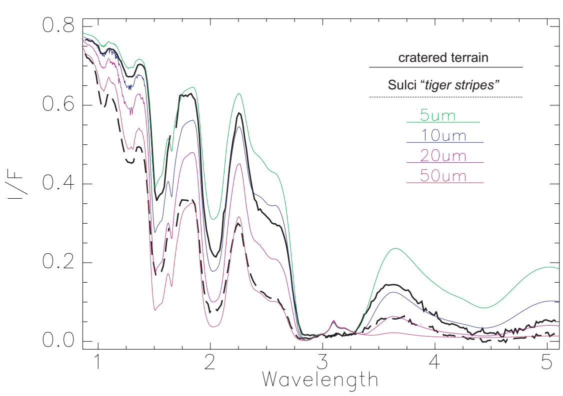

Fig. 5: VIMS reflectance spectra of two terrain types of Enceladus showing water ice with the smallest measured particle size different particles sizes (= old cratered terrain) and the largest particles (sulci, including the "tiger stripes").

Our findings support the results of [1,7] with amorphous water ice being concentrated in older terrain due to the long-term exposure to incoming radiation, and crystalline water ice in the vicinity of the younger resurfaced regions, esp. the South Pole. Amorphization usually goes along with the destruction of water ice particles, resulting in the decrease of mean particle size. Unlike the Galilean satellites, which undergo a daily thermal cycle resulting in the crystallization of ice particles, the surface stays cooler (~70K) [6] on Enceladus and the water ice remains in an amorphous state. In contrast the sulci esp. the "tiger stripes" close to the South Pole are characterized by higher temperature [1,5,6] which leads to the crystallisation and the growing of the particle size.

References: [1] Brown, R. B. et al. (2006) *Science*, in press. [2] Brown, R. B. et al. (2005) *Space Science Rev. 115*, 111. [3] Hansen, G. B. & McCord, T. B. (2004) *JGR, 109*. [4] Kargel, J. S. & Pozio, S. (1996) *Icarus, 119*, 385. [5] Porco, C. C. et al. (2006) *Nature*, in press. [6] Spencer, J. (2005) Eos Trans. AGU, 86 (52) Fall Meet. Suppl., Abstract P32A-04. [7] Hansen, G. B. et al. (2005) Eos Trans. AGU, 86 (52), Fall Meet. Suppl., Abstract P11B-0124.