Comparison of spectral and geological properties of the Saturnian satellites Dione and Rhea.

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The icy Saturnian satellites Dione and Rhea are often regarded as twins with respect to their geological history and spectral surface properties [1-3]. Cassini VIMS detected the satellite surfaces in the wavelength range from 0.35 to 5.2µm and offers the first spatially resolved hyperspectral data of the Saturnian satellites [4] and allow a detailed comparison of their spectral properties. Although the surfaces of Dione and Rhea are mainly composed of water ice, distinct spatial variations of their spectral properties could be derived. Based on the combination of VIMS and digital elevation models derived from ISS data these spectral variations could be associated to specific geological surface features. But also variations independent from geological environment have been observed. On both satellites clean ice deposits exhibiting the largest ice particles measured on these satellites, extend from geologically young impact craters [5]. Their extended ejecta dominate most parts of the leading hemispheres, which has a strong effect onto global hemispherical spectral differences. Icy regions on the trailing side occur in the vicinity of prominent tectonic graben systems with scarps that exhibit slopes of at least 30°. The remaining parts of these hemispheres are characterized by a concentration of non-ice material. The spectral variations on Rhea are less pronounced than those measured on Dione. Their similar spatial distribution, however, implies a similar mechanism responsible for them, i.e. magnetospheric particles that impact onto the trailing hemisphere [6, 7]. This is also supported by similar major spectral characteristics of the dark material on Rhea and Dione [6, 7]. The lesser but still distinct degree of contamination is probably related to different positions of both satellites within Saturn’s magnetosphere. Distinct variations also occur in the measured ratios of the VIMS signal at 0.5 and 0.35µm similar to color variations observed by ISS [8], which are different from what can be seen in the band depth measurements. Although the dominance of the spectral signature of the dark rocky and/or organic material on the trailing hemisphere was expected in this wavelength range, the measured ratio shows an increase in the slope towards the center of both the trailing and the leading hemisphere and a minimal slope exactly at 0 and 180° W, the center of the hemispheres facing toward and away from Saturn. Although an influence of the dark material on the slope from the visible to the ultraviolet spectral range can not be excluded, it does not account for the relatively high ratio on the leading hemisphere. Thus, global processes altering the surface material of both hemispheres due to magnetospheric and/or E ring particles in a similar way must be ongoing.

References: [1] Smith et al. (1981), Science, 212, 163-191; [2] Plescia (1983) Icarus 56, 255–277 ; [3] Clark R. N. et al. (1986), in Saturn, UofA Press, Tucson, Az., p. 437-491; [4] Brown, R.H. et al. (2005) SSR, 115, 115–18; [5] Wagner et al. (2007), LPSC XXXVIII, 1958; [6] Clark et al. (2008) Icarus, 193, 372-386 ; [7] Stephan et al. (2010) Icarus 206, 631-652; [8] Schenk et al. (2010), Icarus, 211, 740-757.