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Ganymede's spectral properties: implications for further investigations in a future mission to Jupiter and its satellites

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Introduction: During the Galileo Mission (1995 – 2003) Ganymede, one of the icy Galilean satellites was observed by the Near Infrared Mapping Spectrometer (NIMS) [1]. NIMS observed the satellite in the spectral range between 0.7 and 5µm with spatial resolutions usually between 40 and 100 km providing a global view of Ganymede's spectral properties. Only few observations show Ganymede's surface with spatial resolutions up to 3 km/pixel making it possible to study the surface in detail.

Spectral variations derived from NIMS measurements: NIMS data provided a first view into the spatial variations of the major spectral signatures of H_2O in Ganymede's reflectance spectra. Spectral variations generally occur in relation to geological surface units with the lowest amount of ice in geologically old regions (with the exception of dark ray craters) and almost clean ice in the vicinity of fresh impact craters [2].

However, band depth ratios of the H_2O absorptions imply that the sizes of the H_2O particles vary with latitude and decrease continuously toward the poles of the satellite (Fig. 1) where H_2O particles smaller than 10µm partly mask spectral characteristics of the geological units underneath [2, 3]. These variations are supposed to reflect the influence of global processes related to Ganymede's environment and are probably caused by the re-deposition of sputtered ice particles in relatively cold surface regions [4, 5].

Because of the relatively low spectral and dynamical resolution of the NIMS data (~26nm and 8bit, respectively) only the distribution of gaseous CO_2, one of the minor surface compounds trapped in the surface material, could be mapped across Ganymede's surface so far [6]. Although these maps are strongly influenced by instrument noise, CO_2 seems to be concentrated in the geologically old heavily cratered terrain of Ganymede's equatorial regions [2, 6]. Detailed analysis of the spectral variations of impact craters with increasing age indicate an equalization of the amount of dark rocky material as well as the CO_2 content of the impact crater material and its substrate [2, 6] with increasing crater retention age. At higher latitudes CO_2 if existent in the surface material at all is eventually masked by the polar frost [6].

Plans for investigations during the future NASA/ESA *Europa Jupiter System Mission* (EJSM): Studying Ganymede's surface is a key element of understanding the Jovian system in several ways. Ganymede is the largest satellite of our solar system and has its own magnetic field, which makes Ganymede perfect for studying the interaction with the magnetosphere of Jupiter, i.e. the chemical and/or physical alteration of the surface material by impacting particles from Jupiter's magnetosphere. This can be done especially at mid-latitudes where the field lines of Ganymede change from closed to open ones. Further, Ganymede combines spectral characteristics of its neighboring satellites Europa and Callisto, i.e. it exhibits tectonic regions, like on Europa as well as geologically old surfaces dominated by impact features, like Callisto.

Although the spatial distribution across Ganymede's surface of the dark rocky material is well known its composition is still a mystery. Thermal segregation is known to be responsible for the concentration of dark material in topographically low regions. So, pure rocky material should be existent at local scale. New spectral observations especially of the heavily cratered terrain as well as the dark ejecta of some impact craters with sufficient spatial resolution (<500m/pxl) would be essential to derive spectral information of the dark rocky material without the influence of H_2O. Further, the identification and mapping of additional minor compounds, especially organics and volatiles [7] with absorptions in the 3-5µm region should provide crucial information concerning the dark rocky material as well but also should give insight into chemical and physical processes in the surface material caused by meteoritic impacts, diurnal temperature variations as well as by the interaction

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with energetic particles coming from Jupiter's magnetosphere.

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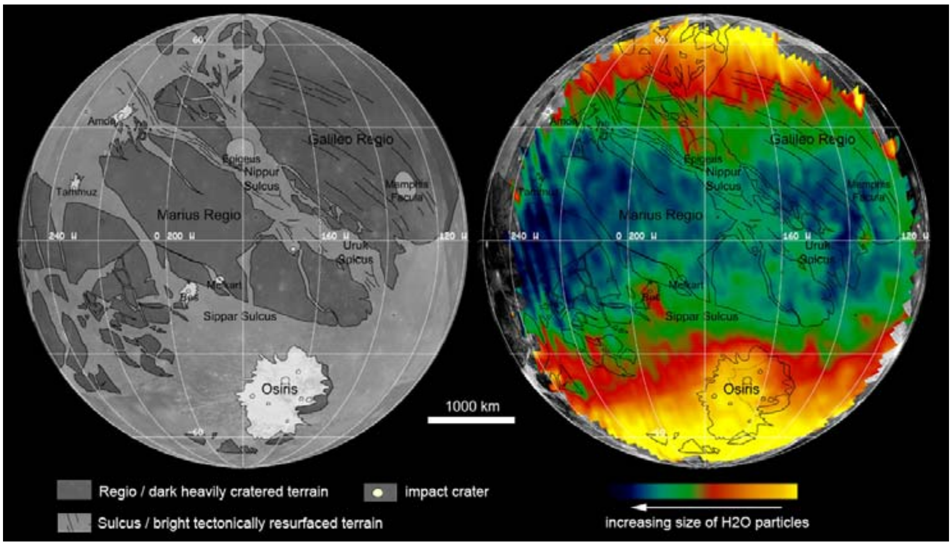

Figure 1: Ganymede's anti-Jovian hemisphere: (left) simple geological map showing the main geological units; (right) H_2O particle size variations.