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Composition and distribution of nonice and trace materials on Ganymede as derived from Galileo observations

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Abstract

Hydrated nonice materials of varying composition and trace amounts of CO_2 and other volatiles are ubiquitous on Ganymede [1,2,3]. The compositions and distributions of these materials are mapped across Ganymede at 1 – 100 km/pixel resolution using infrared reflectance spectra returned by the Galileo Near Infrared Mapping Spectrometer (NIMS), with most coverage at > 10 km/pixel (Figure 1). Although the low spatial resolution and a coarse spectral resolution of ~ 26 nm FWHM limit the inferences that can be drawn, the distributions of the both the volatiles and the various nonice materials are influenced by complex interactions of endogenic and exogenic processes. Through the recalibration of NIMS data and analyses via GIS we are attempting to gain a greater insight into the roles and relative importance of these processes.

The composition of the nonice material ranges from heavily hydrated at high latitudes, similar to that on Europa [3], to only slightly hydrated material associated with dark ray ejecta [4]. However, most of the nonice material on Ganymede, primarily associated with the regiones, is the moderately hydrated material, possibly salts [1]. And it is in this moderately hydrated nonice material that CO_2, the most abundant of the trace materials, appears concentrated [2]. The spectral characteristic of this CO2 appears invariant [2]. Here we focus on the ubiquitous CO_2 that also has the strongest absorption band near 4.26 microns, and indicative of trapped molecules. The CO_2 continues to be only associated with the nonice material on Ganymede, though detection in most of the ice on Ganymede, which is 'large-grained', is problematic because large-grained ice reflectance at 4.26 μm is < a few percent. This low reflectance and radiation induced noise in the NIMS instrument makes detection of shallow

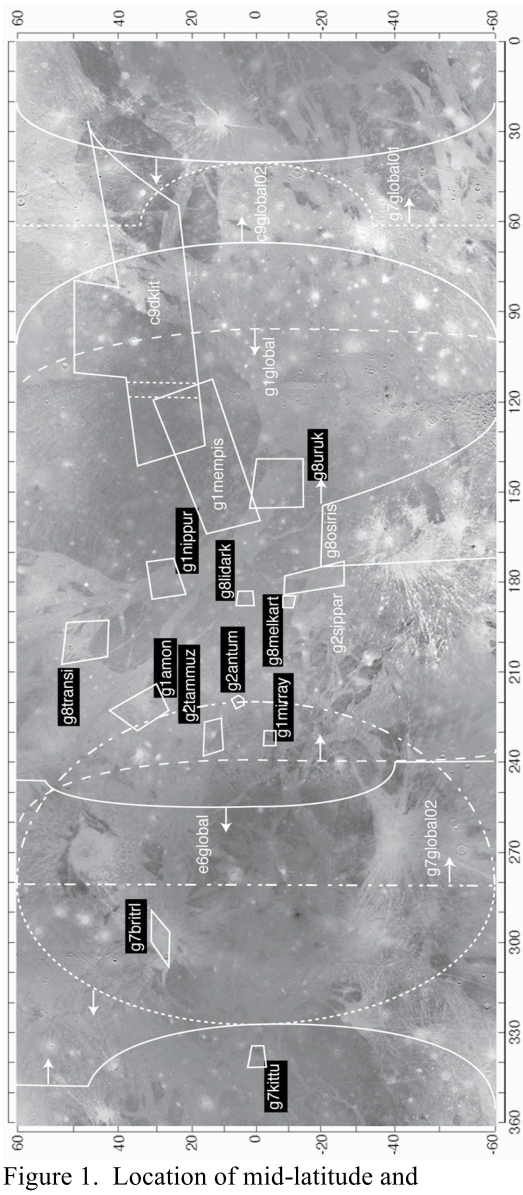

Figure 1. Location of mid-latitude and equatorial Galileo NIMS observations. Black: resolution < 10 km/pixel.

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bands in a low continuum very difficult, though novel processing techniques may hold significant promise [5].

In this work, we use recently recalibrated NIMS data to more accurately derive the spectral nature of and to develop new maps the distribution of the materials on Ganymede, such as CO_2 (Figure 2). New to this effort, are observations from the later orbits of Jupiter by Galileo, the G7, G8, and C9 orbits, where 'G' and 'C' represent close approaches targeting Ganymede and Callisto, respectively. These observations are particularly useful for providing global-resolution context maps to fill in gaps in earlier results [e.g. 6], along with some newly calibrated high resolution images at mid and high latitudes (Figure 1). Previous results are largely being confirmed. However, more accurate maps of the abundance and distribution of CO_2 are becoming available, with new results possible. Unlike on Callisto, impact craters on Ganymede did not appear to be enriched in CO_2, but recent analyses are suggesting that there may be some CO_2-rich impact craters suggesting some commonality between the sisters.

Our reanalyses and mapping are facilitated through the use of GIS database that enables the comparison of maps derived from individual NIMS observations and comparison with geologic maps derived from the Galileo Solid State Imaging subsystem (SSI), without the need for computationally expensive resampling of observations. This is accomplished by converting the spectrometer observations into polygon shapefiles, with each polygon containing information about the reflectance in all channels, and derived maps, such a CO_2 abundance, viewing and illumination geometry, nonice fraction, etc.

Ultimately, however, a full understanding of the composition of Ganymede and the role of exogenic and endogenic processes in shaping its composition will probably not be obtainable from the data available from the Galileo mission alone. Mapping the composition via Vis-IR spectroscopy at sub-km scale and better spectral resolution than NIMS was capable of, along with supporting laboratory measurements for comparison, should provide answers to "nagging" questions such as the composition(s) and origins of the nonice materials, the origin of the CO_2 and other trace materials, and how these materials are trapped in the surface.

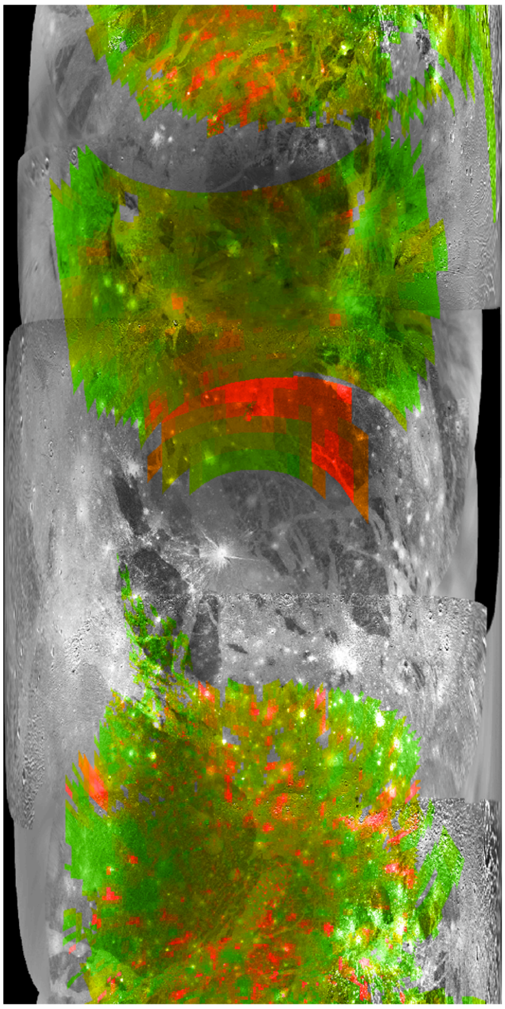

Figure 2. Relative CO_2 abundance (red is more) derived from newly calibrated global observations.

References

[1] McCord et al., *Science*, 292, 1523-1525, 2001.
[2] Hibbitts, C.A. et al., JGR, 108, 203.
[3] Hansen, G. and T. McCord, JGR, 109, 2004.
[4] Hibbitts, C.A. and G.B. Hansen, AAS, DPS, 39, #11.03, 428, 2007.
[5] Stephan, K. et al., Planet. & Space Sci., 56, 406-419, 2008.
[6] Collins, G. et al., LPSC, #2327, 2009.

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