ORGANIC SOLIDS ON SATURN'S SATELLITES D.P.Cruikshank[1], R.N.Clark[2], R.H.Brown[3], B.J.Buratti[4], P.D.Nicholson[5], A. Meyer[6], J.B.. Dalton[4], C.M. Dalle-Ore[7], Y.J. Pendleton[8], & the VIMS Team, [1]MS 245-6, NASA Ames, Moffett Field, CA 94035; Dale.P.Cruikshank@nasa.gov, [2]U.S. Geol. Survey, [3]Univ. Arizona, [4]JPL, [5]Cornell Univ., [6]USRA, [7]SETI Inst., [8]NASA HQ.

Introduction: To the degree that they are chemically unaltered, Kuiper Belt objects, Centaurs, comet nuclei, and small-to-medium size planetary satellites represent primordial material that can offer clues to the composition of the Solar System's nascent molecular cloud and the processes that occurred within the solar nebula during the epoch of planet formation. In addition to rocky material, metals, and ices, it is becoming clear that organic molecular material is also often present. This organic component must be identified and understood as we progress toward a complete view of the original chemistry and processes in the early Solar System that led to the compositions we now see, and to the origin of life, at least on one planet.

Minerals and ices do not give satisfactory spectral model fits to the strongly red-colored surfaces of Solar System bodies, whereas models containing tholins do. Accordingly, it has been assumed for many years that organic solids are present on those surfaces, even though specific and diagnostic spectral absorption bands could not be detected. With the *in situ* study of the satellites of Saturn with VIMS (Visible-Infrared Mapping Spectrometer) aboard the Cassini spacecraft, that situation has changed by the detection of aromatic and aliphatic hydrocarbon bands in the red-colored, low-albedo material on Iapetus, Phoebe, and Hyperion [1,2,3].

New Results from Cassini VIMS: We focus here primarily on Iapetus. The overall spectral reflectance of the low-albedo material on Iapetus shows a very red color, a weak absorption band at 0.67 µm, and a strong absorption band at 3 µm [4,5]. Owen et al. [5] modeled the low-albedo material with an intimate mixture of (nitrogen-rich) tholin, amorphous carbon, and H_2O ice. In their models the tholin provided the red color and a strong absorption band (N-H stretching mode) at 3 µm, matching the albedo, overall spectral shape, and the profile of the 3-µm band throughout the spectral region 0.3-3.8 µm.

The first complete coverage of the spectrum of Iapetus from 0.4 – 5.1 µm was afforded by the VIMS instrument [6] on Cassini in Dec., 2004. Weak residual H_2O ice absorption bands and the 4.27 µm CO_2 band were clearly seen [4]. Initial models of the Cassini VIMS spectrum presented in Buratti et al. [4] use tholins as the principal coloring agent, and also include an HCN polymer, which acts to lower the albedo in the model to match that of Iapetus. Further detailed analysis of the 3.0-3.7 µm spectral region yielded the detection of the 3.3-µm C-H stretching mode band in aromatic hydrocarbons and components of the aliphatic C-H stretching mode band complex [2]. This detection is corroborated and strengthened in additional spectra of the low-albedo surface units obtained at another close flyby of Iapetus in September, 2007.

Discussion: The aromatic and aliphatic hydrocarbon signatures clearly seen on Iapetus are consistent with the presence of aromatic units of small size (perhaps 1-10 rings) linked with short aliphatic bridging units similar to the kind envisioned for meteoritic organic complexes [7]. The aromatic units are thought to be small because the strength of the band indicates the presence of a relatively large number of H-bonding sites per C atom. Because meteoritic insoluble organic matter (IOM) commonly shows a strong aliphatic absorption and little or no aromatic band [8], the aromatic units in the Iapetus material may be significantly smaller than those in the IOM. Note that the absolute strength of the aliphatic band complex (a mixture of -CH_3 and -CH_2 units) is ~10 times that of the aromatic band, so the strength of the 3.3-µm band on Iapetus indicates that aromatic material is abundant.

The low-albedo material on Iapetus and the other Saturnian satellites has the characteristics of hydrogenated amorphous carbon (HAC) that is similar in composition and structure to the carbon-rich organic dust particles in the diffuse interstellar medium [9]. Interstellar HAC is composed of a mixture of aromatic regions (sp^2 bonded systems with a polycyclic aromatic hydrocarbon (PAH) structure) within a matrix of diamond-like (sp^3 bonded) or polymeric (sp^3, sp^2, and sp^1 bonded) material [10]. The conditions of formation and subsequent processing by UV radiation, galactic cosmic rays, and charged particles from the magnetosphere of Saturn influence the instantaneous relative abundances of the various structural components as well as the evolution of this material over time.

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