EPSC Abstracts
Vol. 7 EPSC2012-237-2 2012
European Planetary Science Congress 2012

Possible contribution in DISR spectrum of amino acids derived from Titan's tholins and tholins in organic solvents

D. Nna-Mvondo (1), B. N. Khare (2,3) and C. P. McKay (2)
(1) Centro de Astrobiología (CSIC-INTA) (nnamvondod@cab.inta-csic.es / Fax: +34-915-20-1074), Torrejon de Ardoz, Spain, (2) NASA Ames Research Center, Moffett Field, USA, (3) SETI Institute, NASA Ames Research Center, Moffett Field, USA

Abstract

We have investigated in laboratory the spectroscopic properties of 16 standard amino acids and of urea formed by the hydrolysis of Titan's tholins and of tholins in different organic solvents in a wide spectral range from the visible to far-infrared. The obtained data have been compared with the Huygens Probe's DISR reflectivity spectrum of Titan's surface, in the specific spectral range of DISR instrument (480 - 1600 nm) in order to contribute to the interpretation of the observation.

1. Introduction

On January, 14th 2005, Huygens probe of the Cassini-Huygens mission to the to the Saturn system returned in-situ high-resolution images and data on the composition of Titan's complex surface thanks to its onboard instruments, the Descent Imager/Spectral radiometer (DISR). Apart from the many landforms discovered, DISR camera showed also water ice pebbles coated of tholin-type material lying on a finer grained soil, probably a mixture of water ice and tholins in a substrate of liquid methane. The DISR instrument collected a unique data set of surface reflection measurements from 480 nm to 1600 nm without the interference of methane absorption bands or haze opacity [1]. In the surface reflectivity spectra, water ice absorption band at 1.5 μm has been observed. In addition to water ice, the presence of an organic material absorber resembling laboratory tholin could explain the red slope in the visible of the DISR spectrum. However, the blue slope of the surface spectrum does not match any of the current laboratory data. No combination of any known ice and organic material yet reproduces the characteristics of the blue material.

2. Our study

The present study has been focused on trying to identify possible candidate components for the unknown blue material on Titan's surface and for the overall DISR spectra feature. The point we have raised for this study is that over geologic time, both tholins and condensates of the atmospheric organic gases, accumulating in substantial amounts on the surface as liquid and solid sitting on top of ice, may be chemically reprocessed. They may interact with the water ice of the surface, or even with liquid water which may be present episodically, produced by cryovolcanic activity or by the energy released by large impacts [2]. In this scenario, they could follow hydrolysis processes and could produce a variety of organics, included amino acids and urea and other oxygenated compounds as demonstrated in laboratory experiments [3, 4]. The deposits of the atmospheric organic aerosols may also interact with the hydrocarbons lakes observed on Titan surface [5] and even likely with a liquid water-ammonia medium due to the possible presence of a subsurface water-ammonia ocean [6]. Therefore, we have decided to study in laboratory the spectroscopic properties of several amino acids from Titan's tholins hydrolysis, mixture of amino acids, urea, shock-impacted tholins, hydrated tholins and tholins in non polar solvents.

3. Samples, spectroscopic analysis and first results

Amino acids. We measured the reflectance properties of sample powders of 16 amino acids and urea (at purest analytical grade) which are formed by hydrolysis of Titan's tholins [3]. Drift spectra for each separate amino acid and urea have been first collected. Then different mixtures were prepared by

grinding manually slowly sample powders, in desired weight proportions, in an agate mill inside a laminar flow hood. The following mixture spectra were collected: (a) mixture of all the 16 amino acids at ratio matching those obtained by Khare et al. (1986) [3], (b) mixture all the 16 amino acids all at same ratio. Both mixtures were finally diluted in deionized water and freeze-dried in a lyophilizer (-80ºC, 0.010 mbar) during 5 days before collecting their respective spectra.

Laboratory Titan's tholins. Titan's tholins were produced at NASA Ames Research Center from a N_2/CH_4 = 90%/10% gas mixture by cold plasma irradiation with a RF power supply under a continuous gas flow [7]. Their original spectra were first collected. Droplets of hexane, or isopentane or 15% ammonium hydroxide (analytical grade) were adding gradually in the sample holder in order to measure spectra from moist tholins to solvent saturated tholins.

Spectroscopy. The laboratory diffuse reflectance spectra were acquired in the spectral 50 - 23000 cm^{-1} region using a Fourier Transform Infrared spectrometer configured with a Drift Reflectance accessory mounted inside the instrument compartment. Different optical setups were used to cover this wide spectral range. A XT-KBr beamsplitter and DTGS/KBr detector was used to measure in the MID-IR region from 400 to 11000 cm^{-1}, a Quartz beamsplitter/Silicon detector configuration allowed the spectral analysis in the NIR-visible 9000-16000 cm^{-1}, whereas spectra in the MID-FIR 50-600 cm^{-1} were obtained with a solid substrate beamsplitter / DTGS Polyethylene detector. Spectral resolution was 2 cm^{-1} in the VIS-NIR-MID-IR and 4 cm^{-1} in the FIR. The amount of sample in the sample holder was consistent with infinite thickness.

Results. We compared the reflectivity properties of each amino acid, urea, the mixture of amino acids with or without urea and laboratory Titan's tholins, dry or moist in organic solvents (fig. 1). The first results confirm that the red slope in the visible of DISR could be explained by a complex organic material such as tholins. However they seem to indicate that the blue slope in the near-IR and the single absorption band at 1500 nm do not fit neither tholins nor amino acids nor urea spectral features. We are currently in the data processing of the laboratory spectra of tholins in organic solvents.

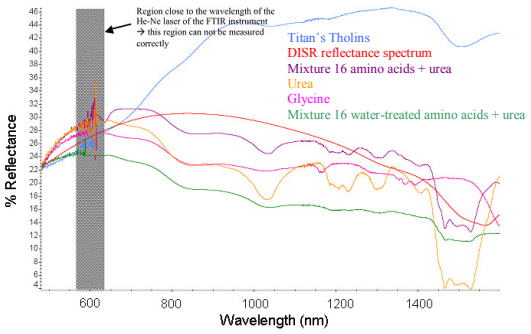

Figure 1: Reflectance spectra of amino acids, urea, laboratory Titan's tholins with DISR Titan's surface spectrum. All the spectra are normalized at 480nm with DISR value [8]

Acknowledgements

D.N.-M. was supported by the Spanish Minister of Sciences and Innovation (MICINN) under the funded project AYA2009-09288.

References

[1] Tomasko, M.G., and 39 colleagues: Rain, winds and haze during the Huygens probe's descent to Titan's surface, Nature, Vol. 438, pp. 765-778, 2005.

[2] Artemieva, N., Lunine, J.: Cratering on Titan: impact melt, ejecta,and the fate of surface organics, Icarus, Vol. 164, pp. 471–480, 2003.

[3] Khare, B.N., Sagan, C., Ogino, H., Nagy, B., Er, C., Schram, K.H. and Arakawa, E.: Amino acids derived from Titan tholins, Icarus, Vol. 68, pp. 176-184, 1986.

[4] Poch, O., Coll, P., Buch, A., Ramírez, S.I., Raulin, F.: Production yields of organics of astrobiological interest from H2O-NH3 hydrolysis of Titan's tholins.

[5] Raulin, F., Brassé, C., Poch, O., and Coll, P.: Prebiotic-like chemistry on Titan, Chem. Soc. Rev., DOI: 10.1039/C2CS35014A, Advance online article, 2012.

[6] Fortes, A. D.: Exobiological Implications of a Possible Ammonia–Water Ocean inside Titan, Icarus, Vol. 146, pp. 444–452, 2000.

[7] Imanaka, H., Khare, B.N., Elsila, J.E., Bakes, E.L.O., McKay, C.P., Cruikshank,D.P., Sugita, S., Matsui, T., Zare, R.N.: Laboratory experiments of Titan tholin formed in cold plasma at various pressures: Implications for nitrogen-containing polycyclic aromatic compounds in Titan haze, Icarus, Vol. 168, pp. 344–366, 2004.

[8] Schröder, S.E. and Keller, H.U.: The reflectance spectrum of Titan's surface at the Huygens landing site determined by the descent imager/spectral radiometer, Planet. Space Sci., Vol. 56, pp. 753-769, 2008.