



HAL
open science

In situ analytical chemistry for the future exploration of Titan

A. D. Morse, Andrews D. J., Barber S. J., M. Bardwell, Nathalie Carrasco, I. Gilmour, Mark R. Leese, Sheridan S., R. Thissen, J. S. Watson, et al.

► **To cite this version:**

A. D. Morse, Andrews D. J., Barber S. J., M. Bardwell, Nathalie Carrasco, et al.. In situ analytical chemistry for the future exploration of Titan. European Planetary Science Congress 2010, Sep 2010, Rome (Italie), Italy. pp.EPSC2010-507. hal-04115386

HAL Id: hal-04115386

<https://hal.science/hal-04115386v1>

Submitted on 11 Jun 2023

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



In situ analytical chemistry for the future exploration of Titan

A.D.Morse (1), D.J. Andrews (1), S.J. Barber (1), M. Bardwell (1), N. Carrasco (2), N., I. Gilmour (1), M.R. Leese (1), S. Sheridan (1), R. Thissen (3), J.S. Watson (1) and I.P. Wright (1)
(1) Planetary and Space Sciences Research Institute, The Open University, Walton Hall, Milton Keynes, MK7 6AA. U.K. (a.d.morse@open.ac.uk) (2) LATMOS Bureau 1219, 11 bld d'Alembert, 78280 Guyancourt, France (3) Laboratoire de Planétologie de Grenoble, Bâtiment D de physique, BP 53, 38041 Grenoble cedex France.

The complex organic chemistry on going at Titan makes it one of the most fascinating objects in the Solar System. Studying the chemical processes that occur on Titan can improve our understanding of processes that may have occurred on an early Earth as simple molecules formed ever more complex organics leading to the eventual development of life. Cassini measurements [5] have shown that organic molecules with a mass $>10\,000$ Da. are produced in the upper atmosphere of Titan due to photolysis and cause the distinctive orange-brown haze associated with Titan's atmosphere.

Terrestrial analogues of Titan organic material have been produced by cold plasma discharge in a nitrogen-methane mixture. Analyses of these tholins have shown that their composition is dependent upon the chemical conditions under which they formed. Hydrolysis of tholins can produce significant quantities of amino acids [1]. A key question for Titan would be whether hydrolysis has occurred, the type of compounds formed and comparing with work carried out on Earth [3].

A Titan chemistry instrument will have to cope with a wide range of materials and should be comparable with techniques used in terrestrial labs so that direct comparison can be made with synthetically produced samples. The proposed Titan chemical analyser uses the powerful technique of GC x GC MS where the sample is separated into individual compounds and then analysed by a high resolution ($M/\Delta M >10\,000$) mass spectrometer. A repeat analysis can then be used to target individual components which are diverted to a separate mass spectrometer for accurate isotopic analysis. Pyrolysis and/or chemical techniques will be required to prepare the samples for analysis and to process the GC elutant for isotopic analysis, similar to that already used on the Ptolemy instrument [2]. Since chemical techniques are already incorporated it is possible to add an ExoMars

biomarker type experiment which can be used to detect specific target molecules [4].

Both Montgolfière and lake landers are suitable platforms for the proposed Titan chemical analysers. A Montgolfière allows a range of atmospheric locations to be analysed over a long duration and would concentrate on the aerosol particles. Isotope analysis would help determine the origin of the initial components. Surface material will consist of loose particles that can be readily grabbed. A lake lander can detect any further chemistry occurring in a liquid environment. Of particular interest would be any sediment occurring at the liquid/solid interface.

References

- [1] Khare, B.N., Sagan, C., Ogino, H., Nagy, B., Er, C., Schram, K.H., and Arakawa E.T.: Amino acids derived from Titan tholins, *Icarus*, 68, pp 176-184, (1986).
- [2] Morse, A.D., Morgan, G.H., Andrews, D.J., Barber, S.J., Leese, M.R., Sheridan, S., Wright, I.P., and Pillinger, C.T.: Ptolemy - a GCMS to measure the chemical and stable isotopic composition of a comet, Springer, 2009.
- [3] Neish, C. D., Somogyi, Á., Lunine, J. L., and Smith M. A.: Low temperature hydrolysis of laboratory tholins in ammonia-water solutions: Implications for prebiotic chemistry on Titan *Icarus*, 201, pp 412-42, 2009.
- [4] Sims, M.R., Cullen D.C., Bannister, N.P., Grant, W.D., Henry, O., Jones, R., McKnight, D., Thompson, D.P., and Wilson, P.K.: The specific molecular identification of life experiment (SMILE), *Planetary and Space Sciences*, 53, pp 781-791, (2005).
- [5] Waite Jr, J.H., Young, D.T., Cravens, T.E., Coates, A.J., Cray, A.J., Magee, B., and Westlake, J.: The process of tholins formation in Titan's upper atmosphere, *Science*, 316, pp 870-875, (2007).

