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Gas-Chromatographic analysis of Mars soil samples with the SAM instrument onboard Curiosity – the 180 first sols

C. Szopa (1), M. Cabane (1), P. Coll (2), D. Coscia (1), A. Buch (3), S. Teinturier (2), R. Navarro-Gonzalez (4), J-P. Goutail (1), C. Montaron (1), J-B. Rigal (1), J-J. Correia (1), V. Guerrini (1), P. Poinson (1), M-S. Clerc (1), M. Meftah (1), L. Soldani (2), F. Mettetal (2), M. Jérôme (2), C. Philippon (2), A. Galic (5), J. Sablairoles (6), S. Triqueneaux (7), D. Chazot (7), B. Toffolo (8), F.Y. Rakoto (8), A. Gaboriaud (9), P. Mahaffy (10) and the MSL Science team cyril.szopa@latmos.ipsl.fr

(1) LATMOS, Univ. Pierre et Marie Curie, Univ. Versailles Saint-Quentin & CNRS, 75005 Paris, France, (2) LISA, Univ. Paris-Est Créteil, Univ. Denis Diderot & CNRS 94010 Créteil, France (3) Ecole Centrale Paris, 92295 Chatenay-Malabry, France. (4) Universidad Nacional Autónoma de México, México, D.F. 04510, Mexico (5) Bureau Veritas then BTP, France. (6) COMAT, 31000 Toulouse France. (7) Air Liquide Advanced Technologies, 38360 Sassenage, France. (8) ATERMES, 78180 Montigny-le-Bretonneux, France. (9) CNES, 31000 Toulouse, France. (10) NASA Goddard Space Flight Center, Greenbelt, MD 20771, USA.

Abstract

Amongst the SAM suite of instruments [1], SAM-GC (Gas Chromatograph) is devoted to identify and quantify volatiles evolved from the thermal/chemical treatment of any soil sample collected by the Curiosity rover. The first soil samples analyzed with SAM were composed of sand collected at the Rocknest site, when the second site analyzed was a basin called “Yellowkive Bay”. For their analysis, these samples were submitted to a pyrolysis at temperatures reaching about 900°C. For SAM-GC and GCMS analyses, different fractions of pyrolysates were collected at different temperature in the ambient-900°C range in order to discriminate potential different volatile fractions present in the solid sample.

With the aim to search for potential organic molecules outgassed from the samples, a SAM-GC analytical channel composed of thermal-desorption injector and a MXT-CLP chromatographic column was used as it was designed for the separation of a wide range of volatile organic molecules. This channel is also equipped with a thermal conductivity detector (TCD) capable to detect the most abundant species (with abundances down to approximately 10⁻¹⁰ mol). It is thus complementary to the mass spectrometer detection for quantification of such species as this last instrument has not a linear response in this domain of high abundance, whereas it is significantly more sensitive than the TCD.

The results obtained with this instrument first show that the performances of SAM-GC are representative

of those obtained during calibrations of the instrument in laboratory, as well as they are repeatable. Hence, the instrument performs nominally, making it the first GCMS running successfully on Mars since the Viking missions. Moreover, the complementarity of GC towards MS is also shown, either by allowing the quantification of the major species detected (as water), or by providing a chromatographic signal well resolved temporally which can be used to improve the QMS signal treatment.

In the frame of research of organics, the SAM-GC analyses contribute to the identification of several methyl-chlorohydrocarbons, and of HCN in the gases evolved from the solid sample. These detections strongly support the presence of perchlorates in the Rocknest soil. Since perchlorates have been detected with Phoenix lander [2] and then recently with Curiosity, the re-interpretation of the Viking data have to be seen under a new angle [3]. The non-detection of PAHs is also interesting to notice, when it is known that micrometeorites containing PAHs still bring this organic material to the Mars surface today. This lack of detection defines an upper limit on the content of PAHs in the martian soil at the sites studied by Curiosity, but it could also be indicative of the presence of chemical mechanisms that process this type of material at the surface.



Fig 1. Curiosity at Rocknest Sandpile, in front of sampling sites.

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