EPSC Abstracts
Vol. 8, EPSC2013-873, 2013
European Planetary Science Congress 2013

Overview of SAM results obtained at Gale Crater during the 180 first sols

P. Coll (1), P.R. Mahaffy (2), M. Cabane (3), C.R.Webster (4), D. Archer (5), S.K. Atreya (6), M. Benna (2), W.B. Brinckerhoff (2), A. Brunner (2), A. Buch (7), P. Conrad (2), D. Coscia (3), N. Dobson (2), J. Dworkin (2), J. Eigenbrode (2), K. Farley (9), G. Flesch (4), H. Franz (2), C. Freissinet (2), D. Glavin (2), S. Gorevan (10), D. Harpold (2), J. Hengemihle (2), F. Jaeger (2), C. Johnson (2), M. Johnson (2), J. Jones (5), M. Lefavor (2), L. Leshin (10), E. Lyness (2), C. Malespin (2), H. Manning (11), D. Martin (2), A. McAdam (2), C. McKay (12), K. Miller (13), D.W. Ming (5), R.V. Morris (5), R. Navarro-González (14), P. Niles (5), T. Nolan (2), T. Owen (15), A. Pavolv (2), B. Prats (2), R. Pepin (16), E. Raaen (2), F. Raulin (1), A. Steele (17), J. Stern (2), S. Squyres (18), B. Sutter (5), R. E. Summons (13), C. Szopa (8), F. Tan (2), S. Teinturier (1), M. Trainer (2), M. Wong (6), J. Wray (19), the SAM Development Team, and the MSL Science Team.

(1) LISA, Univ. Paris-Est Créteil, Univ. Denis Diderot & CNRS, 94000 Créteil, France, (2) NASA Goddard Space Flight Center, Greenbelt, MD 20771, USA paul.r.mahaffy@nasa.gov, (3) LATMOS, Univ. Pierre et Marie Curie, Univ. Versailles Saint-Quentin & CNRS, 75005 Paris, France, (4) Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109, USA (5) NASA Johnson Space Center, Houston TX 77058, USA (6) Univ. Michigan, Ann Arbor, MI 48109, (7) Ecole Centrale Paris, 92295 Chatenay-Malabry, France, , (8) California Inst. of Tech., Pasadena, CA 91109, USA (9) Honeybee Robotics, New York, NY, 10001, USA (10) Rensselaer Polytechnic Inst., Troy, NY 12180, USA (11) Concordia College, Moorhead, MN 56562, USA (12) NASA Ames Research Center, Moffett Field, CA 94035, USA (13) Massachusetts Inst. of Tech,, Cambridge, MA 02139, USA (14) Universidad Nacional Autónoma de México, México, D.F. 04510, Mexico, USA (15) Univ. Hawaii, (16) Univ. Minnesota, Minneapolis, MN 55455, USA (17) Carnegie Inst. of Washington, Washington, DC 20015, USA (18) Cornell Univ., Itha-ca, NY 14853, US (19) Georgia Inst. Technology, Atlanta, GA, 30332

Introduction

During the first 180 sols of Curiosity's landed mission on Mars (8/6/2012 to 2/7/2013) SAM sampled the atmosphere more than a dozen times, the dusty sandpile named Rocknest and a basin site named John Klein on the floor of Gale crater. The atmospheric experiments utilized SAM's quadrupole mass spectrometer (QMS) and its tunable laser spectrometer (TLS) while the solid sample experiments also utilized the gas chromatograph (GC). Although a number of core experiments were pre-programmed and stored in SAM EEProm, the high level SAM scripting language enabled the team to often optimize experiments based on prior runs.

SAM and its Experiment Sequences exercised during the First 120 Sols: The SAM instruments, its gas processing system (GPS) and its sample manipulation system (SMS) have been already described [1]. During the first few weeks of the landed mission SAM carried out a variety of instrument health checks and then began a series of atmospheric experiments to measure atmospheric composition and isotope ratios. From sol 56 to 102 Curiosity lingered at Rocknest to clean out the surfaces of the sample processing system by scooping several times into this fine grained material, vibrating to abrade possible contamination from surfaces, and then discarding before delivery of sample to SAM from the 5th scoop.

1. Atmospheric Isotope Ratios

The $^{40}Ar/^{36}Ar$ determined by introducing gas from the GPS manifold in dynamic mode through a small capillary leak into the QMS is ~$1.9x10^3$. The CO_2 $\delta^{13}C$ of ~45 per mil given by the QMS is consistent with that derived from the TLS. $\delta^{18}O$ measured by the TLS shows that the O in CO_2 is also substantially heavier than the terrestrial average.

2. Atmospheric Mixing Ratios

The mixing ratios of the five most abundant atmospheric constituents as measured by the QMS are shown in Figure 1. Significant differences are present from the Viking results for Ar and N_2, while the mixing ratios of the other gases are consistent with Viking results.

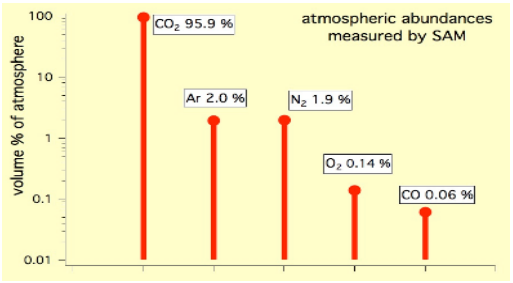

Figure 1. Volume mixing ratios for the five major atmospheric constituents.

3. Gases Evolved from Rocknest Samples

The major volatiles (Figure 2) released from Rocknest solid samples deposited in the SAM quartz cups moved into the oven with the sample manipulation system (SMS) and heated to ~825°C are H_2O, CO_2, SO_2, and O_2. The high temperature component of the evolved CO_2 can be interpreted as decomposition of a Fe or Mg carbonate. Likewise, the evolved SO_2 may be derived from a sulfate or sulfide. Support for the suggestion that the evolved O_2 is produced from the decomposition of a perchlorate such as $Ca(ClO_4)_2$ comes from the evolution of simple chlorinated compounds coincident with the O_2. Water at several weight percent was the most abundant gas released from these samples with possible or likely minor species H_2S, HCN, C_2H_3N, and NO also detected (Figure 2).

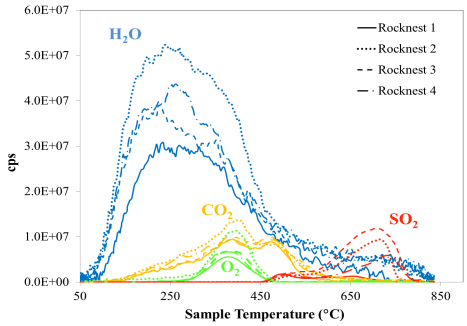

Figure 2. Major gases from Rocknest samples.

Rocknest GCMS Results: All the elements of the GCMS system including thermal conductivity detectors (TCD's) of the GC system performed as designed and produced a wealth of data. Four chlorinated compounds (as well as H_2O, SO_2, & HCN) were detected by the SAM GCMS analysis of the first three Rocknest sample delivered to SAM. In addition, several products of the residual MTBSTFA (N-Methyl-N-tertbutyldimethylsilyltrifluoro-acetamide) were found to be present in the SAM SMS and these are detected both in the direct and the GCMS parts of the sequence.

4. First drilled sample at Yellowknive Bay

We will also present the preliminary results relative to analyses of veins and nodules observed in 'Yellowknife Bay' of Gale Crater, where a patch of sedimentary rocks were observed by Curiosity. This is in such area that Curiosity found evidence of an ancient environment compatible for microbial life.

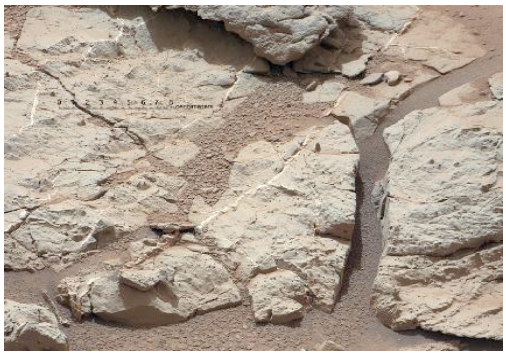

Figure 3. This image of an outcrop at the "Sheepbed" locality, shows well-defined veins filled with whitish minerals, interpreted as calcium sulfate. These veins form when water circulates through fractures, depositing minerals along the sides of the fracture, to form a vein.

Acknowledgments

The SAM experiment was supported by NASA and the GC element of SAM by CNES.

Reference

[1] Mahaffy P.M. et. al. (2012) Space Sci Rev, 170 (401–478)