ANALOGUE EXPERIMENTS IDENTIFY METEORITIC PRECURSORS FOR ALL ORGANIC COMPOUNDS DETECTED BY SAM IN GALE CRATER R.E. Summons[1], J. Herrera[1], A. Sistiaga[1], K.E. Miller[1], S.S. O'Reilly[1], J.L. Eigenbrode[2], D.P. Glavin[2], C. Freissinet[2], P. Coll[3], C. Szopa[4], M. Millan[4], A. Buch[5], R. Navarro-González[6] and the SAM and MSL science teams. [1]Department of Earth, Atmospheric and Planetary Sciences, MIT Cambridge MA (rsummons@mit.edu), [2]NASA Goddard Space Flight Center, Greenbelt, MD, [3]LISA, Créteil, France [4]LATMOS, Guyancourt, France, [5]Ecole Centrale Paris, Châtenay-Malabry, France, [6]Universidad Nacional Autónoma de México.

Introduction: Since landing at Gale Crater Gale Crater (4.5°S, 137.4°E) on August 6, 2012, the Sample Analysis at Mars (SAM) instrument suite aboard the Curiosity Rover has conducted multiple analyses of scooped and drilled sediment samples and has identified a collection of chlorinated hydrocarbons including chloromethane, dichloromethane, trichloromethane, chloromethylpropene, 1,2-dichloroethane, 1,2 dichloropropane, 1,1- and 1,2-dichlorobutanes and chlorobenzene[1-3]. These compounds were identified after samples were pyrolysed at temperatures up to ~835°C through a combination of Evolved Gas Analysis (EGA) and Gas Chromatography Mass Spectrometry (GCMS) and were well above the background levels, as determined by empty cup blanks analyzed prior to solid sample analyses. Laboratory experiments conducted with the MXT-CLP column (SAM GC-5 channel) used for the GC–MS analyses of the martian soil samples support all the compound identifications made to date[4].

Following the unambiguous detection of perchlorate by the Phoenix lander, Navarro-Gonzalez and colleagues conducted 'Viking-like' pyrolysis experiments on terrestrial soils from the Atacama Desert containing 32 ± 6 ppm of organic carbon mixed with 1 wt% magnesium perchlorate upon which chloromethane and dichloromethane were identified as products[5,6]. Other analog experiments constrain the characteristics of molecules that are prone to chlorination by the products of perchlorate decomposition under SAM-like pyrolysis conditions[7].

In the present study, we pyrolyzed a simple Mars analog soil comprising olivine sand mixed with Murchison meteorite in the ratio 95: 5. No other salts or minerals were present. This was pyrolyzed alone and after addition of 1% and 5% calcium perchlorate and utilizing three heating rates. The perchlorates were added aqueous solution to aliquots of the analog soil and dried overnight. Internal standards of pyrene and decafluorobiphenyl were included to aid recovery estimates.

Pyrolysis of Murchison meteorite yields suites of mono- to triaromatic hydrocarbons and small organosulfur compounds comprising thiophene together with mono- and dimethyl analogs and benzothiophene, as previously reported[8]. Pyrolysis in the presence of 1% perchlorate afforded mixtures of chlorinated alkanes and chlorbenzenes and thiophenes all of which have been identified in SAM analyses of samples at Gale Crater. Pyrolysis in the presence of 5% perchlorate resulted in much diminished yields overall with trichloromethane, carbon tetrachloride and chlorobenzene the main products identified. Product yields were optimal when using a ballistic heating ramp and declined significantly as the heating rate was lowered. In the presence of perchlorate we observed a trade-off between chlorination and combustion with combustion predominating at low heating rates. In summary, we find that meteoritic organic matter, pyrolyzed in the presence of perchlorate can account for all the organic compounds identified, so far, by SAM

References: [1] Glavin, D. et al. (2013) JGR 118, 1955-1973. [2] Leshin L. et al. (2013) Science 341. [3] Freissinet, C. et al. (2015) JGR, 325 64-67. [4] Millan M. et al. (2016) Planetary and Space Science 129, 88–102. [5] Navarro-Gonzalez et al., (2010) JGR 115, E12010. [6] Navarro-González et al (2011) JGR 116, E08011. [7] Miller et al. (2016), JGR 121, 296-308. [8] Sephton, M.A. (2012)Mass Spectrometry Reviews 31, 560-569.