VAPOR BREADBOARD DEVELOPMENT, FIRST PYROLYSIS RESULTS. I. L. ten Kate[1,2], C. A. Malespin[3], D. P. Glavin[1], and the VAPoR team, [1] NASA Goddard Space Flight Center, Code 699, Greenbelt, MD 20771, Inge.L.tenKate@NASA.gov, [2] Goddard Earth Science and Technology Center, University of Maryland Baltimore County, Baltimore, MD 21228, [3] Auburn University, Auburn, AL 36849, USA.

Introduction: The identification of lunar resources such as water is a fundamental component of the the NASA Vision for Space Exploration. *In situ* composition and isotopic analyses of the lunar regolith will be required to establish the abundance, origin, and distribution of water-ice and other volatiles at the lunar poles. Volatile Analysis by Pyrolysis of Regolith (VAPoR) on the Moon using pyrolysis mass spectrometry (pyr-MS) is one technique that should be considered. The VAPoR instrument concept study and development was recently selected for funding by the NASA Lunar Sortie Science Opportunities Program and the NASA Astrobiology Instrument Development Program. The VAPoR instrument suite is a miniature version of the Sample Analysis at Mars (SAM) [1] instrument suite currently being developed at NASA Goddard for the 2009 Mars Science Laboratory mission, and will include a sample manipulation system (SMS), vacuum pyrolysis unit, gas processing system, and mass spectrometer (quadrupole or time-of-flight, Fig. 1). The VAPoR suite has a lot of heritage from the SAM suite.

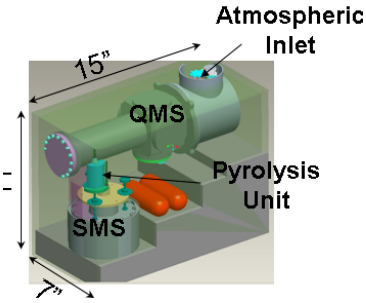

Figure 1. The VAPoR pyr-MS instrument, with the Atmospheric Inlet, the Sample Manipulation System (SMS), the Pyrolysis Unit and a Quadrupole Mass Spectrometer (QMS).

Science Objectives: The three major lunar science measurement objectives of the VAPoR instrument are (1) Measure the isotope ratios of carbon, hydrogen, oxygen, and nitrogen (CHON)-containing volatiles including water in polar regolith to establish their origin, (2) Understand the processes by which terrestrial organic compounds are dispersed and/or destroyed on the surface of the Moon to prepare for future human exploration and life detection on Mars, and (3) Measure the abundance of volatiles that can be released from lunar regolith for *in situ* resource utilization (ISRU) technology development.

Breadboard development: In order to test the different components of the VAPoR instrument package as well as to provide first calibration data a breadboard has been built (Fig. 2), consisting of a stainless steel vacuum chamber equiped with a modified Knudsen cell (K-cell), which serves as pyrolysis unit, and a residual gas analyzer (RGA, a commercial quadrupole mass spectrometer). The breadboard will evolve in time with the addition of flight hardware.

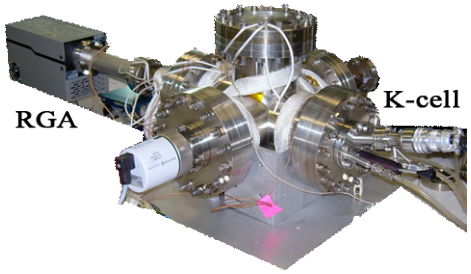

Figure 2. The VAPoR breadboard, equipped with the Residual Gas Analyzer (RGA) and the K-cell.

Experiments: A wide range of tests and experiments have been conducted in which different samples of ~50 mg have been pyrolised at rates of 5 °C per min to 1200 °C, while the RGA continuously recorded spectra of the evolving gases. The samples used in these experiments included the lunar simulants GSC1 [2] and JSC1A [3], Apollo 16 lunar regolith, and a Murchison meteorite sample.

Results: Preliminary results of JSC1A and Apollo 16 regolith are shown in Fig. 3. Further results from the different samples will be presented at the conference.

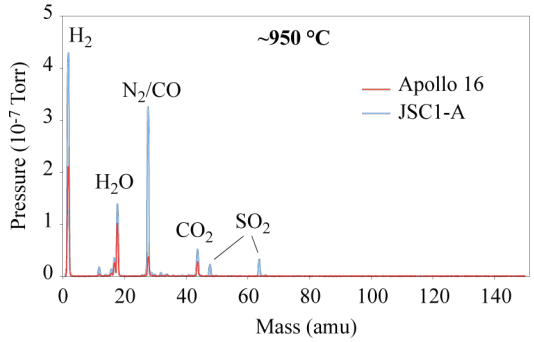

Figure 3: A pyrolysis spectrum of JSC1A (in blue) and Apollo 16 regolith (in red) at a temperature of 950 °C. SO_2 is found in the JSC1A sample, however not in the Apollo 16 sample.

References: [1] Mahaffy, P. M. (2007) *Space Sci. Rev.* [2] Taylor, P. T. et al (2008) *NLSI Lunar Science Conference*, 2054, [3] isru.msfc.nasa.gov/lib/Documents/JSC-1A_Bulk_Data_Characterization_ draft.pdf