HYPOBARIC CONDITIONS WITHIN ROCK VOID SPACES ON MARS WILL LIKELY INHIBIT THE REPLICATION OF TERRESTRAIL MICROORGANISMS.
Andrew C. Schuerger[1], and Daniel Britt[2]. [1]University of Florida, Bldg. M6-1025, Space Life Sciences Lab, Kennedy Space Center, FL 32899; email: schuerg@ufl.edu; [2]Dept. of Physics, University of Central Florida, Orlando, FL 32816; email: britt@physics.ucf.edu.

Introduction: Many diverse niches have been proposed for the search of an extant martian microbiota including caves, hydrothermal vents, subsurface ices, buried liquid brines, and porous rocks on the surface. Of these niches, surface rocks are the easiest to access from rovers, and will likely be prime targets for future life detection experiments. Thus, it is important to understand if drilling operations into rock surfaces on Mars could emplace terrestrial microorganisms from the rover that will subsequently colonize the rock internal void spaces. The objective of the research was to characterize the internal pressure, temperature, and humidity of diverse rock types under martian conditions. Results will help model the potential for microbial contamination of the martian surface from landed or crashed vehicles, and may help constrain the search for an extant microbial community on Mars.

Materials and Methods: A Mars Simulation Chamber (MSC; Fig. 1) was used to create conditions similar to equatorial Mars (described in full by Schuerger et al. [1]. The MSC system can accurately simulate five key components of the surface environment of Mars including: (a) pressures down to 0.1 mb; (b) UVC, UVB, and UVA irradiation from 190 to 400 nm; (c) dust loading in the atmosphere from optical depths of 0.1 to 3.5; (d) temperatures from –100 to +30 C; and (e) an atmospheric mixture of CO_2 (95.53%), N_2 (2.7%), Ar (1.6%), O_2 (0.13%), and H_2O (0.03%).

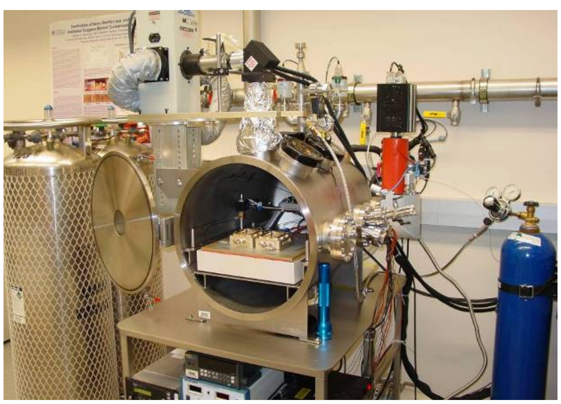

Fig. 1. Mars Simulation Chamber (MSC).

Ferruginous banded sandstone (trace # 47E0444; Ward's Natural Science, Inc), basalt (trace # 47E1038), and red ochre hematite (trace # 46E0949) were drilled to a depth of 2 cm with a 7-mm wide steel carbide bit. Temperature, humidity, and pressure sensors were inserted into the drilled holes; the wires surrounded with glass wool; and the holes sealed with two types of epoxy. First, Loctite epoxy (Henkel Consumer Adhesives, Inc, Avon, OH) was used to initially attach the sensors to the rock surfaces within the drilled bore holes. Once cured, a second epoxy (EP-21, Master Bond, Inc., Hackensack, NJ) was used to seal the wire leads and to extend the epoxy patches to 1.5 cm in diameter around the drilled bore holes. A 5 cm^3 aluminum block was drilled and prepared as above, and served as a non-rock control to monitor the outgassing of the internal void space conditions along sensor wire leads. Rocks were individually exposed to a diversity of martian conditions to determine outgassing rates, temperature lags, and loss of humidity as the Mars chamber was pumped down to 6.9 mbar.

Results and Discussion: The normal pump-down rate for the Mars chamber to go from Earth sea level pressures near 1013 mbar to the simulated martian surface pressure of 6.9 mbar was approximately 5-6 min. The aluminum block outgassed the internal void space atmosphere around the sensors at the rate of 22 mbar/h at the start of each pump-down cycle, and slowed to <10 mb/h after 24 h. In contrast, the internal rock void space conditions in banded sandstone and hematite rocks equilibrated with martian pressures within 5-6 min; identical to the overall rate observed for the Mars chamber as a whole. The basalt sample required approx. 60-70 min to equilibrate to 6.9 mbar; significantly longer than the sandstone and hematite rocks, but still much faster than the aluminum block.

Relative humidity for all rock types tested required between 3 h for the sandstone and hematite rocks, and 8 h for the basalt to equilibrate to the relative humidity within the Mars chamber (9-10%).

Results indicate that the internal void spaces within the three rocks rapidly equilibrated to typical conditions found on equatorial Mars at the aeroid, and makes it unlikely that niches within the upper layers of martian rocks will retain water activities ($a_w \geq 0.62$; [2]) and pressures ($\geq$ 25 mbar; [3,4]) high enough to sustain metabolism and replication of terrestrial microorganisms. Thus, microbial replication, adaptation, and colonization in shallow rock subsurface niches by spacecraft microbes appear unlikely on Mars.

References: [1] Schuerger et al. (2008) *Icarus*, 194, 86-100. [2] Beaty et al., (2006) *Astrobiology*, 6(5), 677-732. [3] Schuerger et al., (2006) *Icarus*, 185, 143-152. [4] Kral et al., (2010) *Planet. Space Sci*., doi: 10.1016/j.pss.2010.07.012.