FAST DEGASSING RATES UNDER SIMULATED MARTIAN CONDITIONS INDICATE THAT ROCK VOID SPACES ARE UNLIKLEY TO MAINTAIN HABITABLE CONDITIONS ON MARS. Andrew C. Schuerger[1], and Daniel Britt[2], [1]Dept. of Plant Pathology, Univ. of Florida, Exploration Park, Merritt Island, FL 32953, schuerg@ufl.edu. [2]Dept. of Physics, Univ. of Central Florida, Orlando, FL 32816; dbritt@ucf.edu.

Introduction: Recently, 31 bacteria from diverse ecosystems have been identified that are capable of growth under simulated Martian conditions of low-pressure (0.7 kPa), low-temperature (0 ^{o}C), and CO_2-enriched anoxic conditions [henceforth called *low-PTA conditions*] [1,2,3]. Furthermore, with the discovery of cryptoendolithic microbial and lichen communities in Antarctica sandstones [4], porous rocks have been proposed as potential habitable niches on Mars. The objective of this study was to determine if sublimating frosts could hydrate internal void spaces in rocks under low-PTA conditions. Results might provide insights into locations on Mars to search for extant life.

Methods: A Mars Simulation Chamber (MSC) [5] was used to measure the internal relative humidities (RH) in three rock types to determine if surface frosts would increase internal RH above water activities (a_w) > 0.61, that are required for cellular growth [6]. Ferruginous banded sandstone, basalt, and red ochre hematite were drilled to a depth of 2 cm with a 7-mm wide steel carbide bit. Temperature, pressure, and RH sensors were inserted into the drilled holes, covered with glass wool, and epoxied into the rock. A 5 cm^3 of solid aluminum was drilled and fitted with sensors, as described above, and served as a non-porous control.

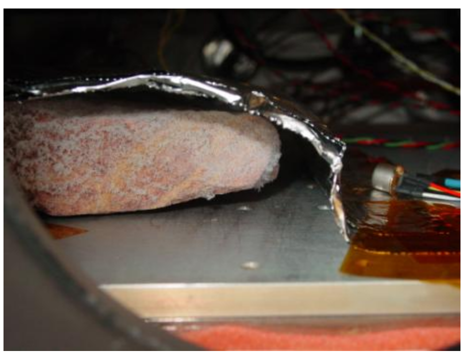

Fig. 1. Frost-covered banded sandstone viewed through external view port on the MSC system.

Instrumented rocks were exposed to low-PTA conditions with temperatures between –100 and 30 ^{o}C. Frosts on the rocks (Fig. 1) were created by attaching an external tube below an aluminum foil cap to direct hydrated Mars gas directly to the pre-chilled rocks (≤ –70 ^{o}C). Once a frost layer had persisted for several hours, the liquid nitrogen (LN2) cold plate was warmed slowly to 30 ^{o}C to measure the RH in the rock void spaces as the temperature transitioned through 0 ^{o}C.

Results and Discussion: The aluminum block outgassed the atmosphere surrounding the sensors at the slow rate of < 1 kPa/h after 24 h. In contrast, all rock types quickly lost their internal pressures during the MSC pump-downs to 0.7 kPa; usually between 10 (sandstone and hematite) to 60 (basalt) min (Fig. 2); orders of magnitude slower than the aluminum block control. The internal RHs within the rocks also rapidly decreased and reached an equilibrium close to 9-10% RH between 3 h (sandstone and hematite) and 8 h (basalt) after the depressurization was initiated.

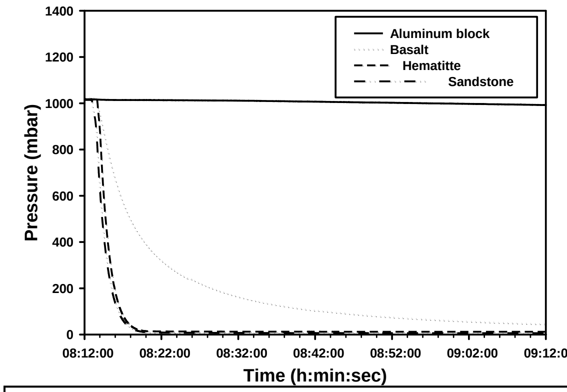

Fig. 2. Rapid degassing of all three rock types occurred between 10 (sandstone and hematite) and 60 (basalt) min.

When the rocks were heated from –100 to 30 ^{o}C, the frosts would begin to sublimate at –70 ^{o}C completing the sublimation process as the rock surfaces reached –30 ^{o}C. In no simulation did the RH (and by extrapolation the a_w) exceed 0.61 in the internal void space of the rocks during the heating phase.

Results indicate that internal void spaces within the rocks are likely to be in equilibrium with the surface atmosphere on Mars, and make it unlikely that internal surface rock niches will retain $a_w \geq 0.61$ long enough to sustain cellular metabolism and replication of microorganisms. Thus, microbial replication, adaptation, and colonization appear unlikely in shallow rock subsurface niches by spacecraft microbes on Mars.

References: [1] Schuerger A.C. et al. (2013) *Astrobiology*, 13, 115-131. [2] Nicholson W.L. et al. (2013) *PNAS*, 2, 666-671. [3] Schuerger A.C. and Nicholson W.L. (2016) *Astrobiology* 16, 964-976. [4] Friedmann E.I. (1982) *Science*, 215, 1045-1053. [5] Schuerger, A.C. et al. (2008) *Icarus*, 194, 86-100. [6] Rummel, J.D. et al. (2014) *Astrobiology*, 14, 887-968.

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