HEAT TOLERANCE OF METHANOGENS R. K. Tryon[1] and T. A. Kral[2], [1] University of Arkansas, Fayetteville, AR 72701, rktryon@uark.edu, [2]Department of Biological Sciences, University of Arkansas, Fayetteville, AR 72701, tkral@uark.edu.

Introduction: So far Martian exploration has consisted of three different phases: Flybys, Orbiters, and Landers and Rovers. The Flyby missions consisted of Mariners 3 and 4, and Mariners 6 and 7 starting in 1964. These gave us the first close-up photographs ever taken of the Red Planet. The Orbiter missions began with Mariners 8 and 9 in 1971 and ended in 2005 with the Mars Reconnaissance Orbiter. They were used to gather advanced information about the terrain of Mars. More recently, Landers and Rovers have been sent to the surface of Mars in search of more definitive data concerning the Martian soil, terrain, and environmental conditions. The most recent of these Landers was the Phoenix mission that drilled down into the Martian soil to reach an ice layer and to analysis the sample searching for evidence of whether or not the planet is or has even been a plausible dwelling place for living organisms. This probe also gave a high-resolution perspective of the local terrain and geography so they could determine successful digging sights for soil samples [1].

Methane, a gaseous molecule at Earth temperatures and denoted by the chemical formula CH_4, is composed of the two of the most common atoms on Earth. It is also known that, "living systems produce more than 90% of Earth's atmospheric methane" [2]. This observation fueled the interests of scientists who were postulating on whether or not life could exist on Mars. They knew that if methane could be found on the Martian planet, then it would be a spring-board to further inquiries into the possible existence of living organisms on Mars. In 2003, NASA scientists analyzed for methane and water vapor on Mars and were surprised by how often their samples were positive for methane. This information has lead scientists to hypothesis that this new and more prominent presence of methane on Mars might be due to its creation as a by-product of a living system just as it is on Earth [2].

Criteria for a living organism that would be capable of living in the extreme environments on Mars are vast. According to the Biology Cabinet [3]: "Mars is a planet with scarce water, it has not a protective ozone layer, its gravity is weaker than Earth's gravity and practically it has not a magnetic field." In addition, any organism living on Mars would need to be capable of living in extreme cold since NASA scientists feel Mars has been an icy frozen planet for billions of years [3]. Considering the extreme environment, if there is life on Mars, a plausible organism would be a methanogen.

Methanogens are model organisms because their requirements for life are much less than for many other living organisms. According to the Science Daily [4], "methanogens seem to be a potential candidate for what life on Mars might look like -- they produce methane and live in harsh, anaerobic environments, such as the guts of animals, in deep parts of the ocean or in the Earth's crust." In addition, the byproduct they produce when performing life sustaining functions is methane.

In 2011, Russia plans to launch the Phobos Grunt-mission which will go to the Martian satellite Phobos and collect soil samples to return to Earth [4]. The Planetary Society will be sending a passenger along, the Living Interplanetary Flight Experiment, which will include 10 types of microorganisms and a natural soil sample. One of those microorganisms is *Methanothermobacter wolfeii.* One of the questions that is currently unanswered is the heat tolerance of this organism to re-entry temperatures.

Methods: Methanogens used in this series of experiments were *Methanothermobacter wolfeii* and *Methanosarcina barkeri*. Experiments were conducted at the boiling temperature (100^{o}C) of water. Organisms were grown in their ideal media, centrifuged, dried, and exposed to the test temperature for various lengths of time, from one minute up to one hour. Following this exposure, the cell pellets were suspended in their ideal growth media under anaerobic conditions, and incubated at their optimal temperatures. Gas chromatographic measurements of methane were recorded at regular time intervals.

Results: Both *M. barkeri* and *M. wolfeii* demonstrated survival following various times of heat exposure (Figures 1 and 2).

Conclusion: Overall, results so far indicate that both methanogens can survive 100^{o}C for various lengths of time with *M. barkeri* surviving longer than *M. wolfeii*.

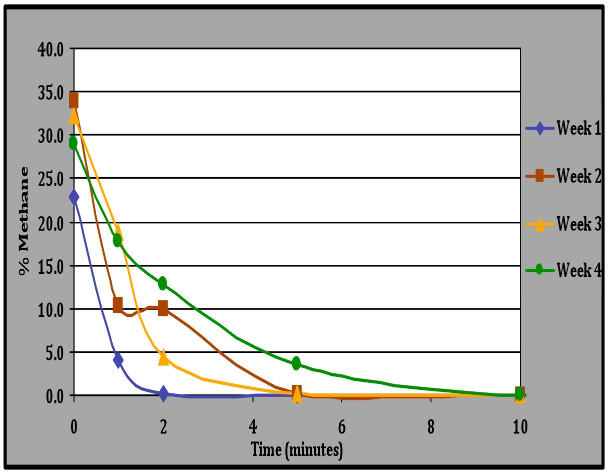

Figure 1. Methane production by *Methanothermobacter wolfeii* following exposure to 100°C for various periods of time.

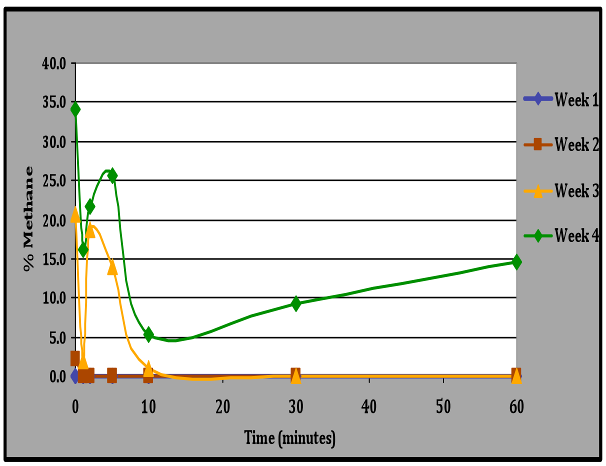

Figure 2. Methane production by *Methanosarcina barkeri* following exposure to 100°C for various periods of time.

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