Simulating Martian Conditions: Methanogen Survivability During Freeze/Thaw Cycles

S Djordjevic[1,2], RL Mickol[1], TA Kral[1,3]

[1] Arkansas Center for Space and Planetary Sciences, University of Arkansas, Fayetteville, Arkansas, United States of America
[2] University of Illinois at Urbana-Champaign, Champaign, Illinois, United States of America
[3] Department of Biological Sciences, University of Arkansas, Fayetteville, Arkansas, United States of America

Background

- Extensive evidence of methane in the martian atmosphere (Fig. 1; avg. 10 ppb) [1-6]
- Methanogens are obligate anaerobes that tolerate a wide range of conditions
- It is proposed that methanogens are able to metabolize and survive in these martian conditions (Fig. 2)
- Temperature and pressure will be analyzed to determine growth and survivability (Fig. 3)

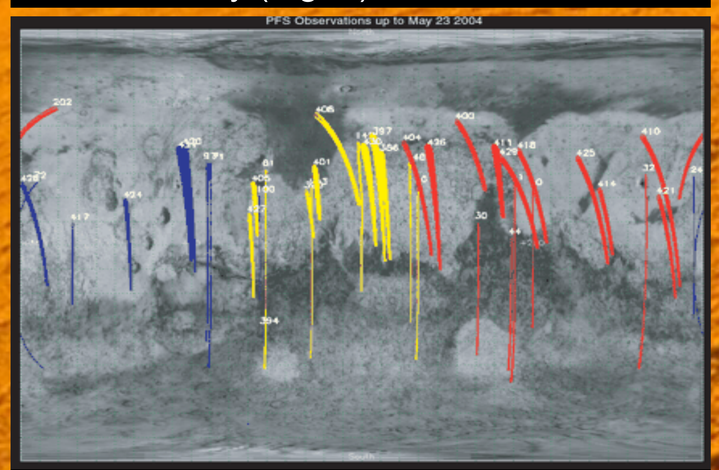

Figure 1
Methane distribution on Mars from data obtained from the Mars Express orbiter [1].

ATP generation

$$CO_2 + 4H_2 \rightarrow CH_4 + 2H_2O$$

Figure 2
Methanogens generates methane by using CO_2 as a carbon source and H_2 as an energy source.

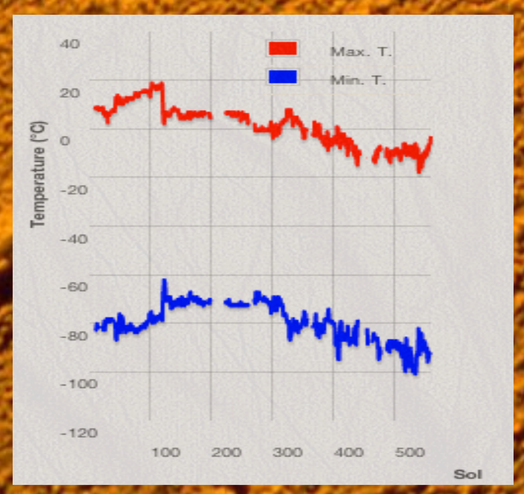

Figure 3
Ground temperature data from the Rover Environmental Monitoring System from early-August 2012 to the present time at Mars' Gale Crater [7].

Methods

- Media prepped according to Kendrick and Kral [8] (Fig. 6)
- Media inoculated with 0.5 mL of respective methanogen (*M. barkeri*, *M. formicicum*, *M. maripaludis*, *M. wolfeii)*; grown at ideal growth temperature (*M. barkeri*/*M. formicicum* at 37°C, *M. maripaludis* at room temperature (22°C), and *M. wolfeii* at 55°C)
- Solutions transferred to various temperatures (Figs. 4, 5) and growth monitored by methane production using gas chromatography
- Solutions were grown in 5 or 10 grams of sand (Fig. 5)

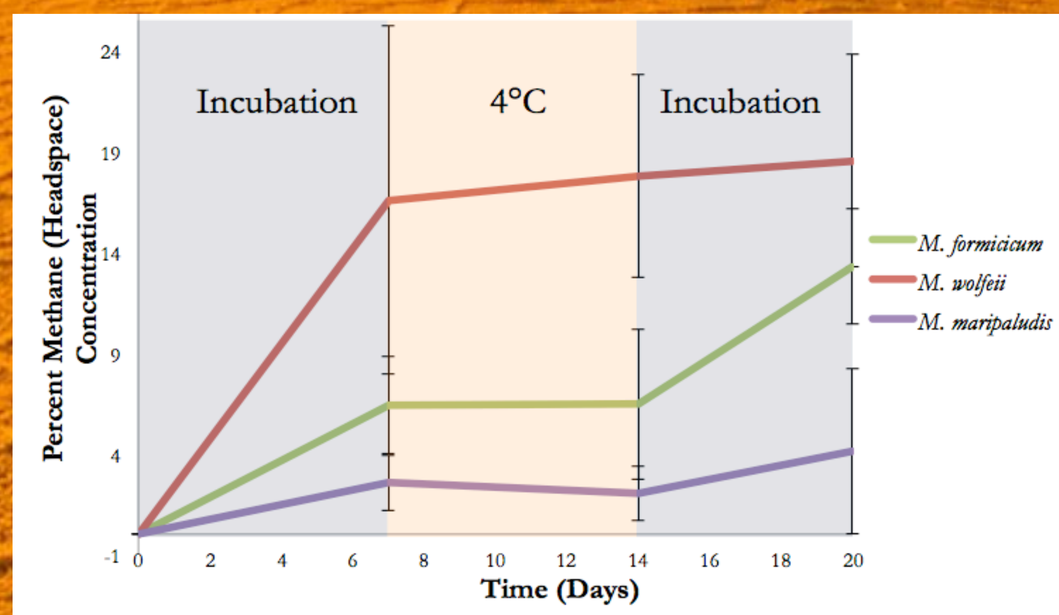

Figure 4
Percent methane (headspace) concentrations for each of three methanogen strains (*M. wolfeii*, *M. maripaludis*, *M. formicicum*) following a seven day incubation period, a 4°C freeze-thaw cycle, and subsequent incubation period. Error bars represent one standard deviation.

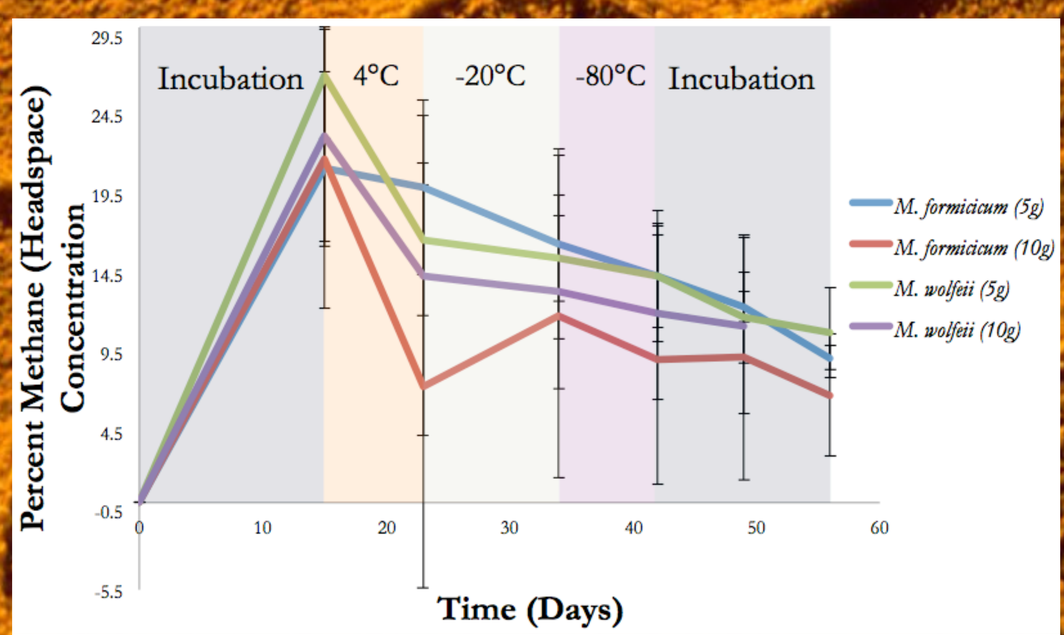

Figure 5
Percent methane concentrations in media inoculations containing either 5 or 10 grams of sand following 7 day incubation period and various freeze/thaw cycles (*M. barkeri*/ *M. maripaludis* not viable). Error bars represent one standard deviation.

Figure 6
Coy Anaerobic Environmental Chamber used for media prep (90% CO_2/10% H_2).

Results and Conclusions

- Methane concentration greater than 5% was interpreted as growth/survivability
- Incubation at 4 degrees slowed or inhibited growth at that temperature, but was not lethal since the organisms continued growing at their ideal growth temperatures afterward
- *M. barkeri*/*M.maripaludis* displayed little (<5% CH_4) to no growth during freeze/thaw cycles and their data is not shown here
- Survival indicates that future experiments should be conducted

Further Studies

- Find temperature/pressure constraints for each species in order to understand implications for life in Martian conditions.
- Longer freeze/thaw studies conducted (Mickol RL. et. al. this conference, Abstract #1603)

References

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