



Approaching Martian Conditions: Methanogen Survival at Low Pressure

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BACKGROUND

- Mars surface pressure averages 6 mbar, just 1/1000th that of Earth.
- Few studies have considered the effects of low pressure on organism growth and survival [1, 2, 3].
- Four methanogen species (*Methanobacterium formicum*, *Methanosarcina barkeri*, *Methanothermobacter wolfeii*, *Methanococcus maripaludis*) were tested for their ability to survive under low pressure conditions, approaching those found on Mars.

METHODS

- 50 mL of 4 types of methanogen growth medium (MM, MS, MSH, MSF) were prepared [4], with 10 mL of each medium added to each of 5 test tubes
- Sterile 2.5% Na₂S solution added to tubes following sterilization via autoclave
- Each tube was inoculated with 0.5 mL of the corresponding methanogen (MM: *M. wolfeii*; MS: *M. barkeri*; MSH: *M. maripaludis*; MSF: *M. formicum*) and pressurized with H₂
- Inoculated tubes were incubated at ideal growth temperatures and tested for methane via gas chromatograph
- Tubes were placed inside Pegasus Planetary Simulation Chamber [5] (Fig. 1)
- Chamber evacuated to 1 mbar, filled with 80:20 H₂:CO₂ gas to 100 mbar, and evacuated again to 1 mbar (cycle repeated 3 times)
- Chamber set at desired pressure
- Tubes were punctured after 2 days, with a specialized device
- Two experiments were run: at 67 mbar and at 33 mbar

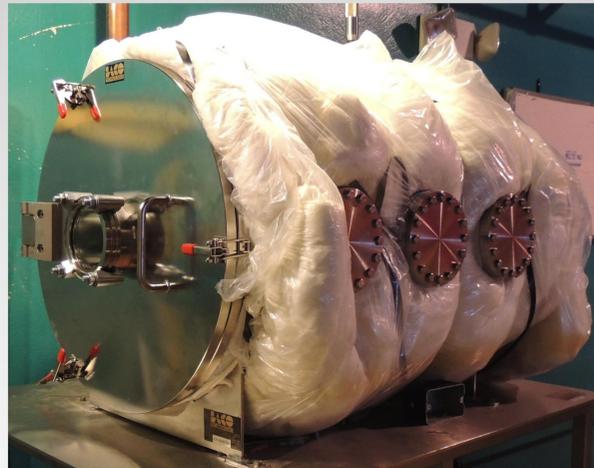
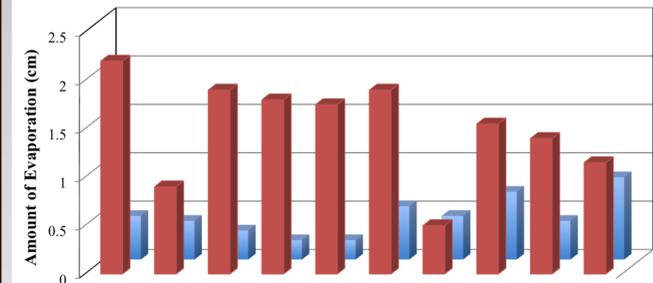
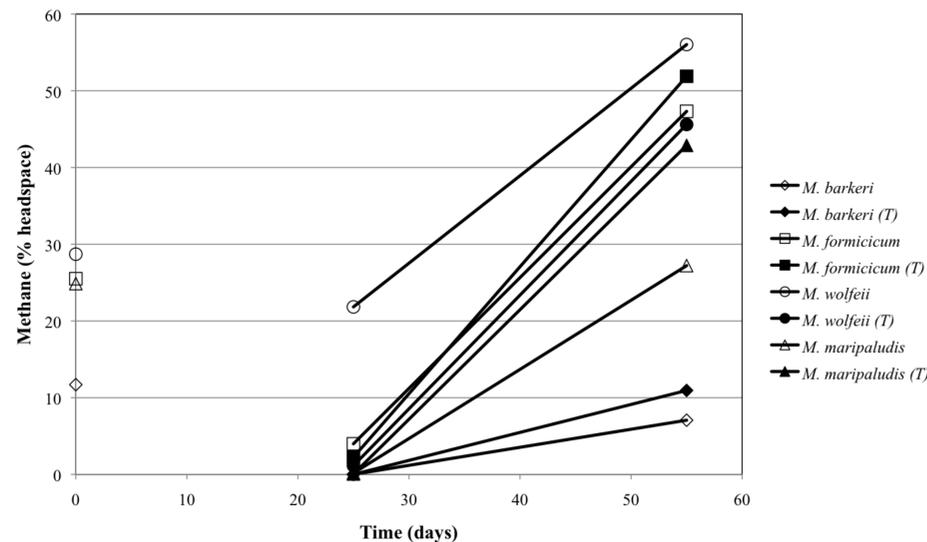


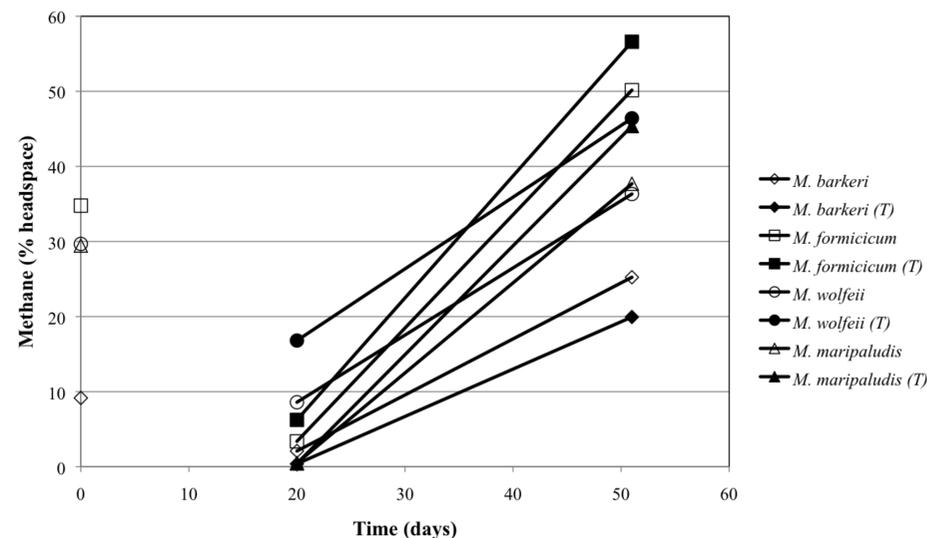
Figure 1 (left). Pegasus Planetary Simulation Chamber. Insulated chamber with viewports, connections to analysis equipment.
Figure 2 (right). Experiment 2, 33 mbar. Total evaporation (in centimeters) for each of 20 test tubes exposed for 6 days to 33 mbar.



RESULTS



Figures 3, 4. Average methane produced (% headspace) for each of four methanogen strains (*M. barkeri*, *M. formicum*, *M. wolfeii*, *M. maripaludis*). Day 0 refers to the day the original tubes were placed in the Pegasus Planetary Simulation Chamber. **Above:** Experiment 1, 67 mbar. **Below:** Experiment 2, 33 mbar.



DISCUSSION/CONCLUSIONS

- All 5 replicates for all 4 methanogen strains survived exposure to both 67 mbar and 33 mbar (Figs. 3, 4)
- Average methane production was generally similar for each species for both experiments (Figs. 3, 4)
- Average methane production was slightly higher in transfer tubes than original tubes (except *M. wolfeii* in Exp. 1, *M. barkeri* in Exp. 2)
- No evaporation occurred in Exp. 1 (67 mbar), with noticeable variation in evaporation in Exp. 2 (33 mbar)
- Future experiments will be conducted at lower pressures (6 – 10 mbar) as well as test diffusion barriers to slow evaporation (such as JSC Mars-1, etc.)

References

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Experiment 1

Experiment 2

Pressure (mbar)

67 – 73

33 – 40

Time un-punctured

14 days

7 days

Time exposed to low pressure

11 days

6 days