



Can Terrestrial Microbial Life Survive and Grow on Mars?

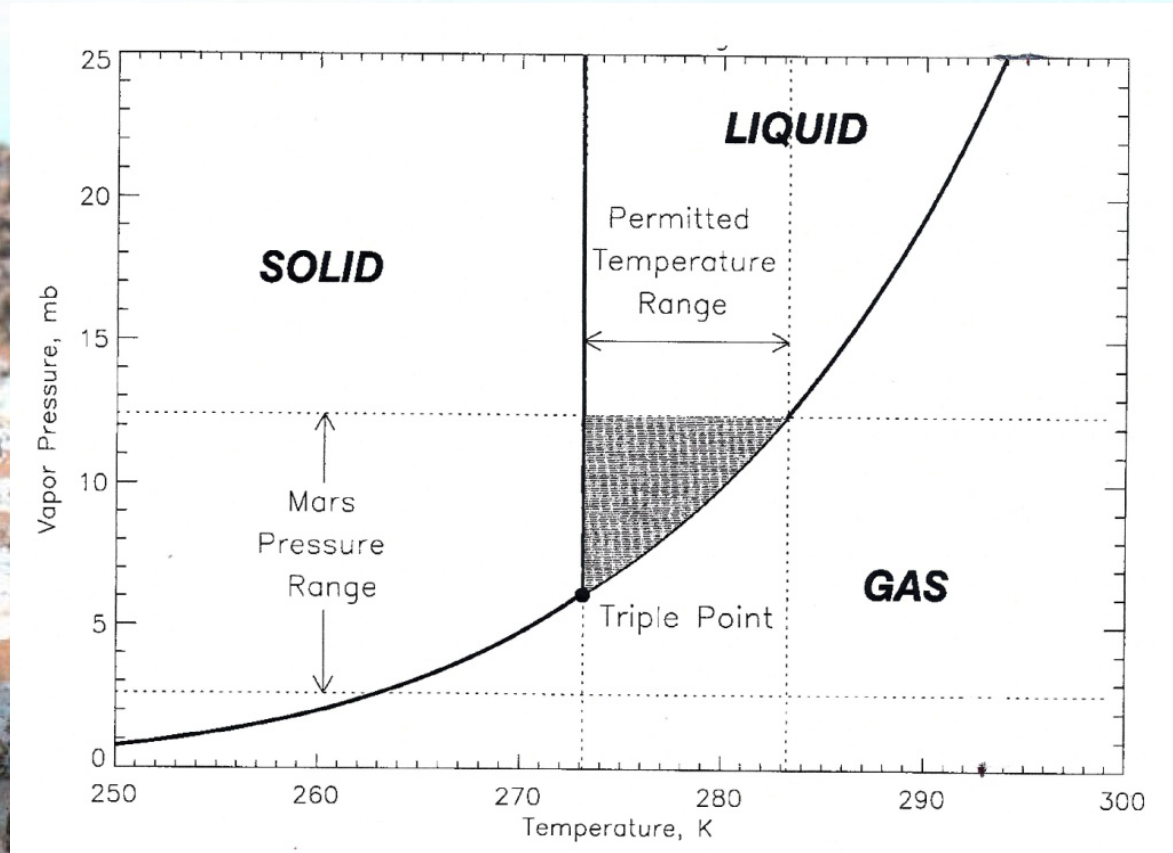
Andrew C. Schuerger, University of Florida, Gainesville, FL

17 Biocidal or Inhibitory Factors on the Surface of Mars

Schuerger et al., 2013, *Astrobiology*, 13, 115-131.

- (1) solar UV irradiation
- (2) extreme desiccating conditions (i.e., low water activity; a_w)
- (3) low pressure (7 mbar)
- (4) anoxic CO₂-enriched atmosphere
- (5) low temperature
- (6) high salts levels [e.g., MgCl₂, NaCl, FeSO₄, and MgSO₄] in surficial soils
- (7) galactic cosmic rays
- (8) solar particle events
- (9) UV-glow discharge from blowing dust
- (10) solar UV-induced volatile oxidants [e.g., O₂⁻, O⁻, H₂O₂, O₃]
- (11) globally distributed oxidizing soils
- (12) high concentrations of heavy metals in martian soils
- (13) acidic or alkaline conditions in martian soils
- (14) perchlorates in most soils
- (15) lack of defined energy source free of UV irradiation
- (16) no sources of available nitrogen and carbon
- (17) no obvious redox couples for microbial metabolism

Can Earth microbes grow on Mars?...plausible but unlikely.



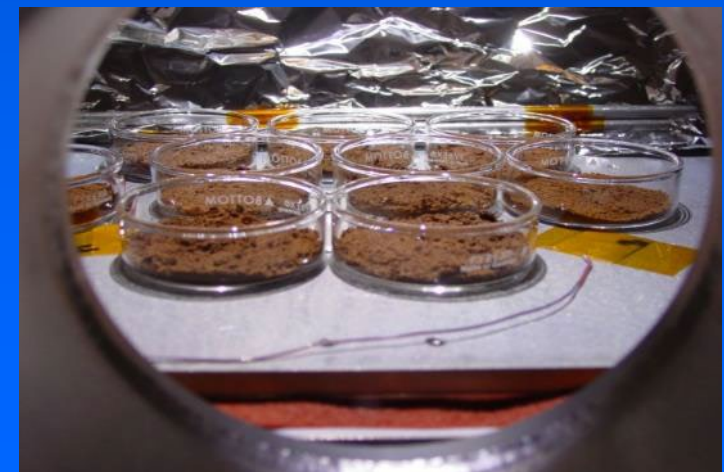
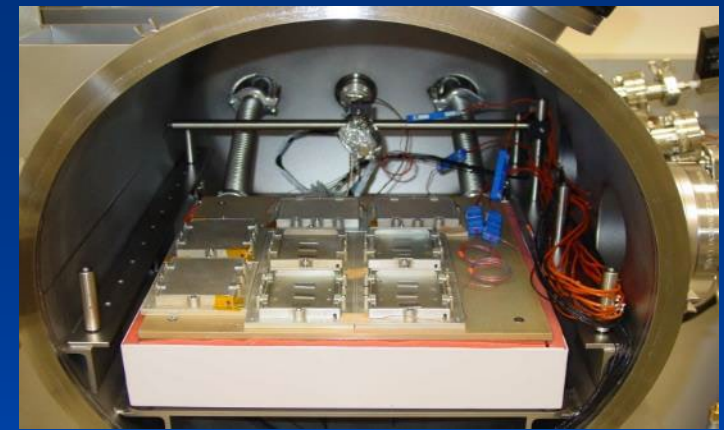
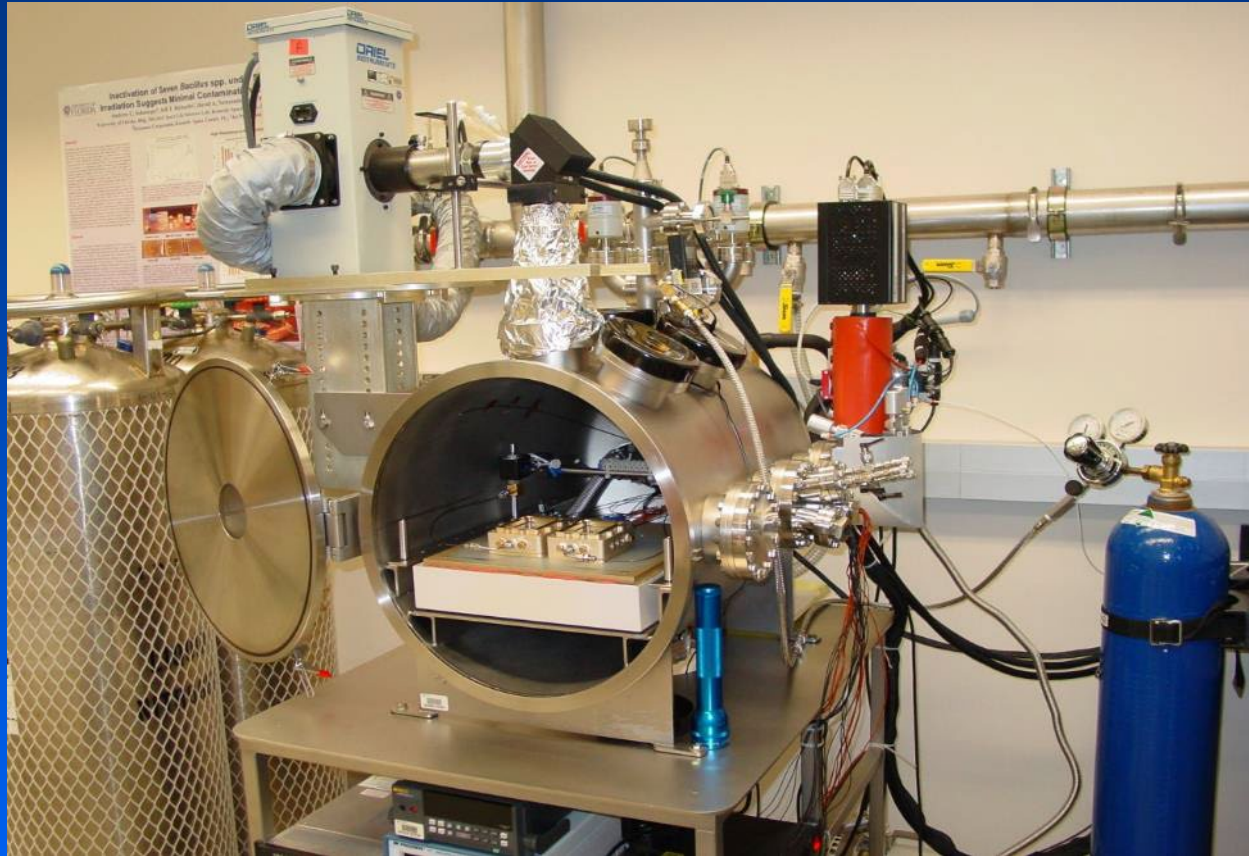
Haberle et al., 2001, *JGR*, 106(E10).

Viking 2 Lander

Transient melting hypothesis: Head et al., 2011; Wall, 1981.

Mars Simulation Chamber (MSC)

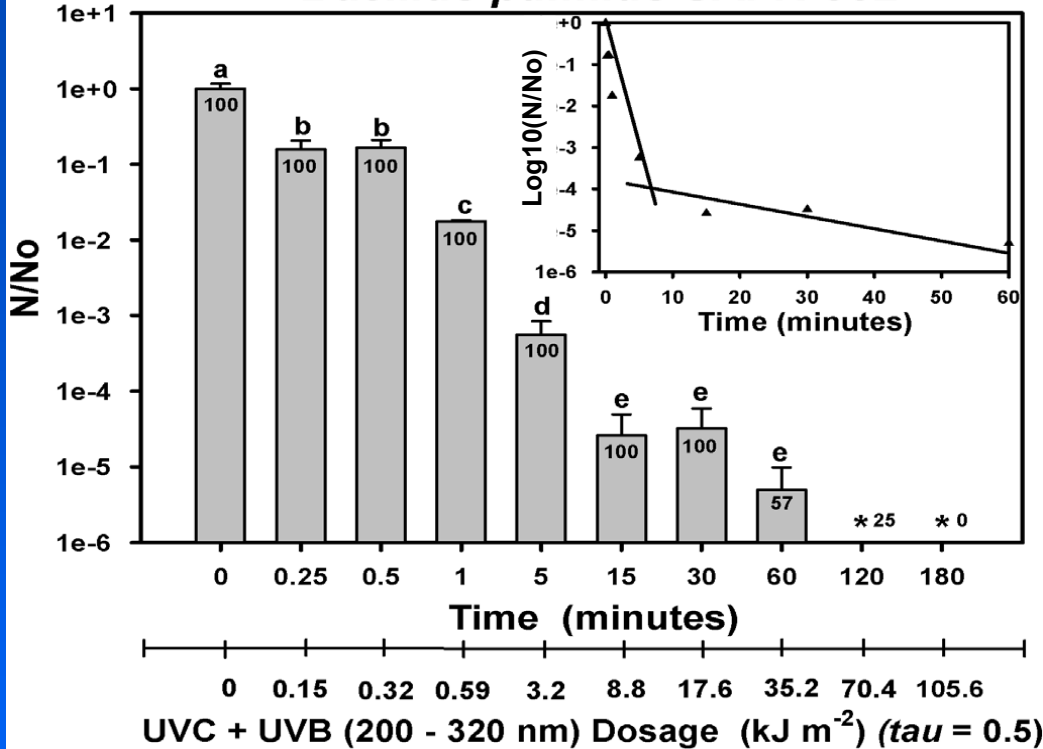
Schuerger et al., 2008, *Icarus*, 194, 86-100.



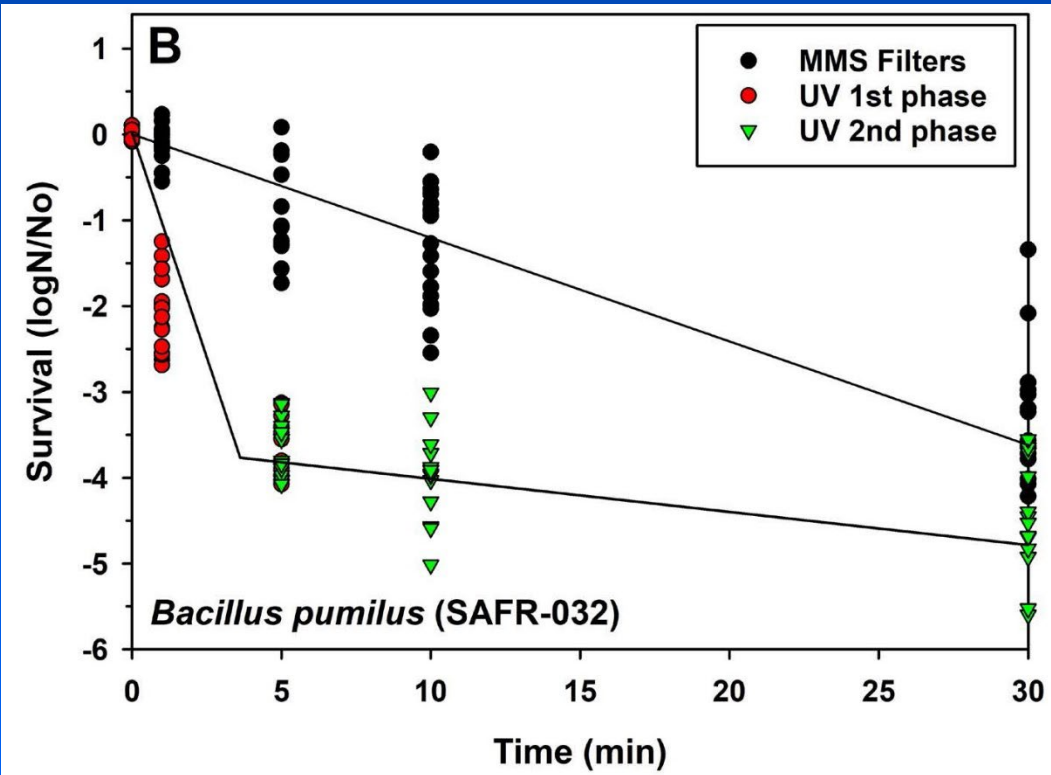
- Pressure: down to 0.01 mbar
- Temp: -100 to +160 °C (programmable)
- Gases: CO₂; O₂/N₂; Mars mix (top 5 gases)
- UV-VIS-NIR: equatorial to polar fluence rates
- Dust loading from *tau* 0.1 to 3.5

Bacillus pumilus SAFR-032 UV Lethality Data from 2006 and 2023

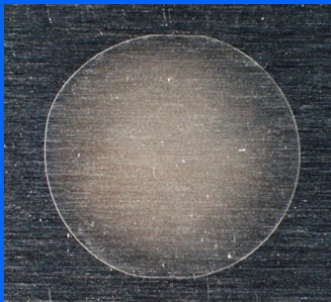
Bacillus pumilus SAFR-032



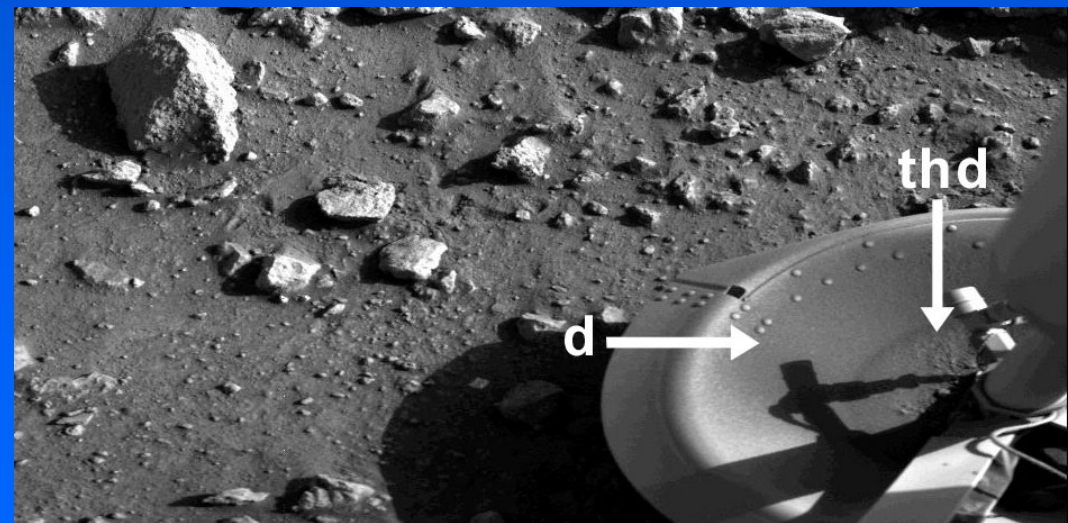
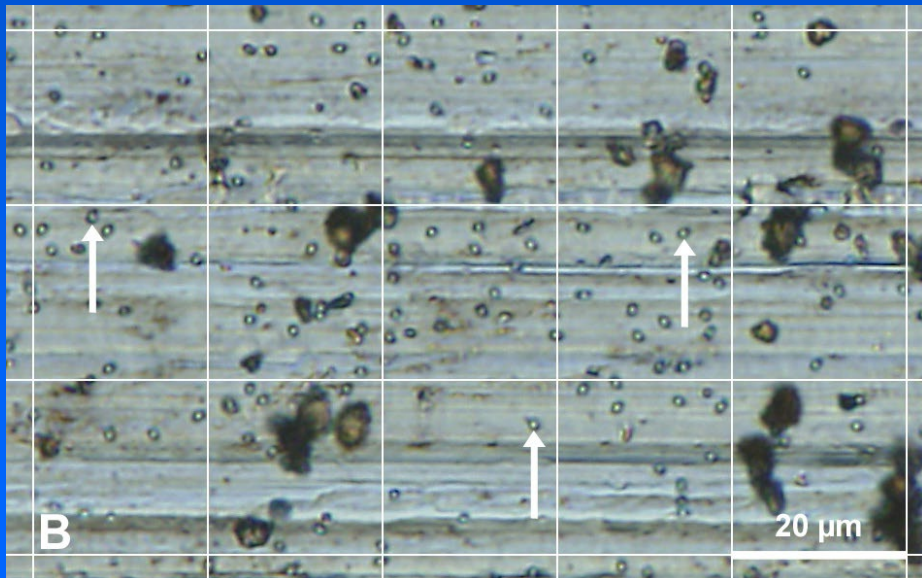
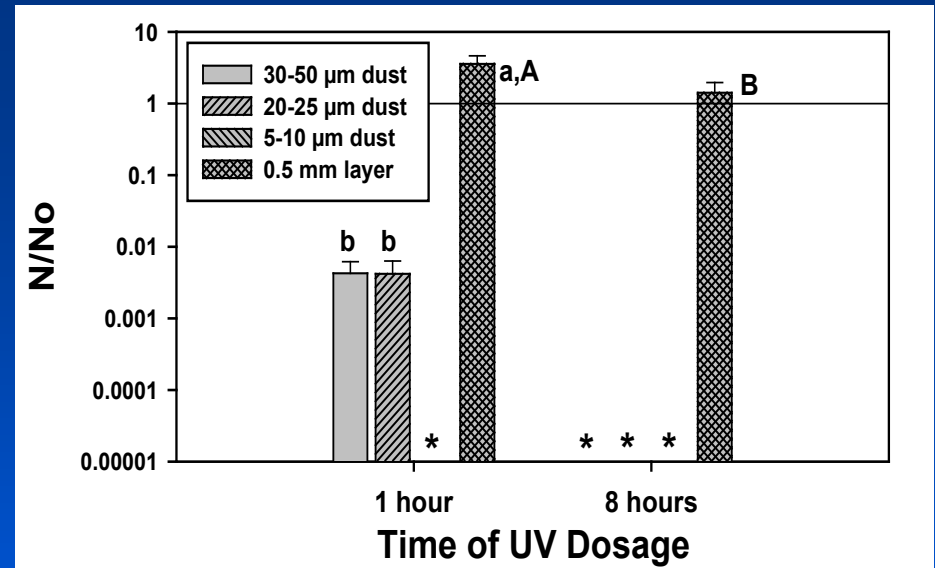
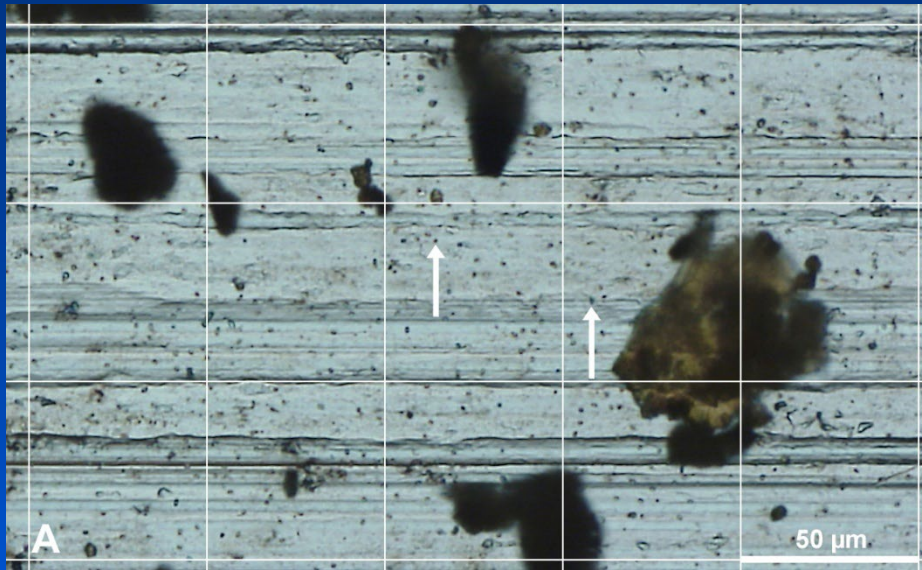
Schuerger et al., 2006, *Icarus*, 181: 52-62.



Schuerger et al., 2024, JPL grant.

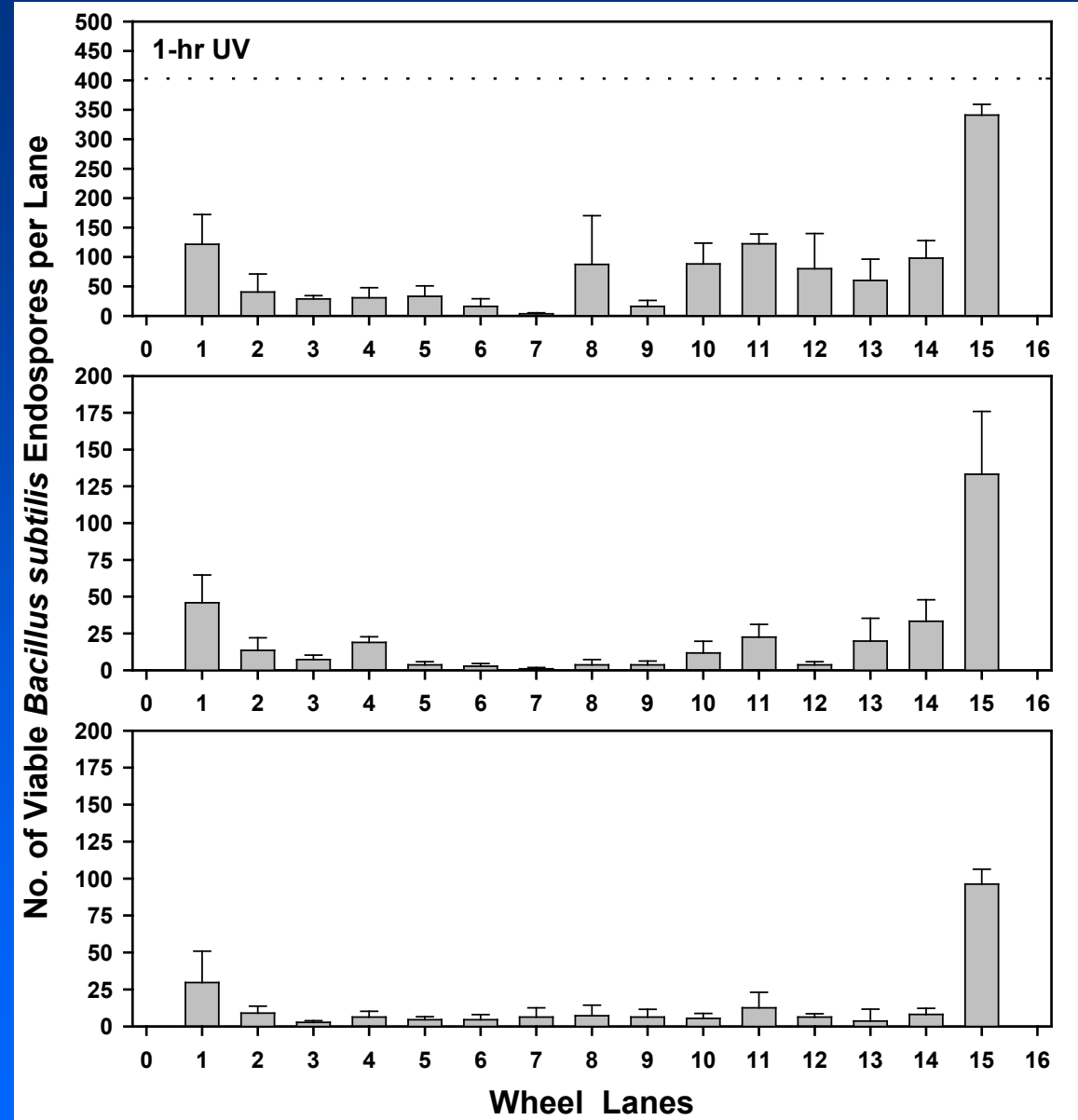
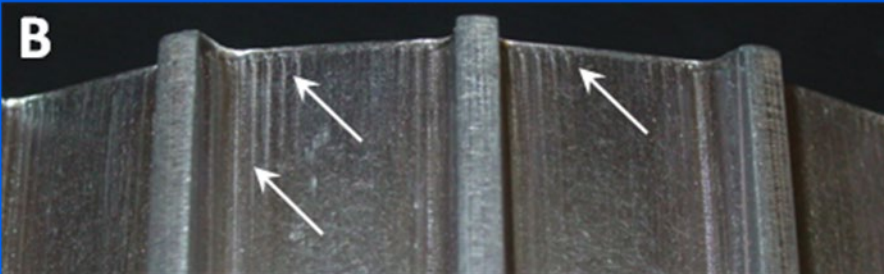
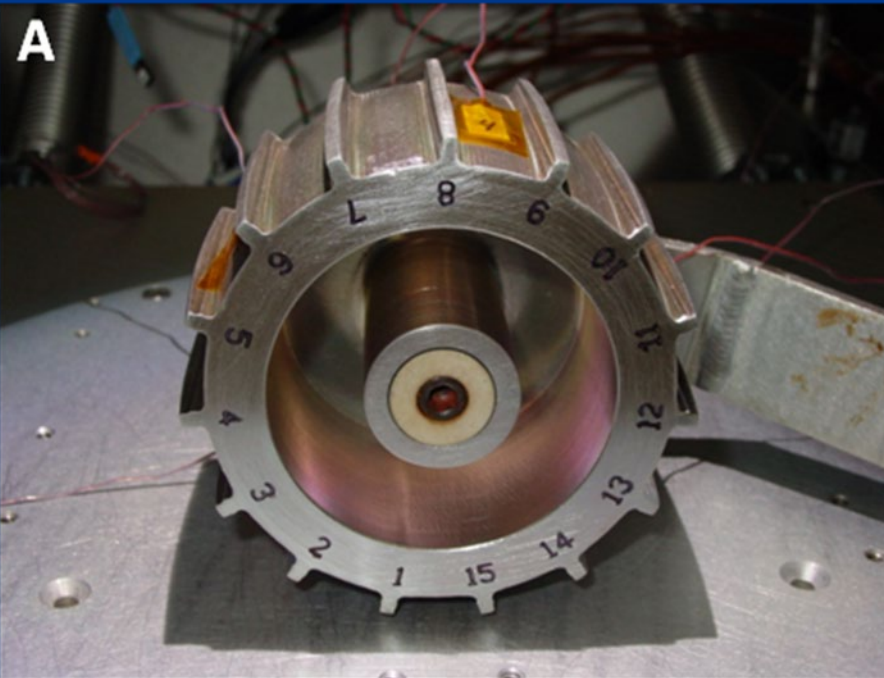


UV Scattering around Dust Particles on Spacecraft Surfaces

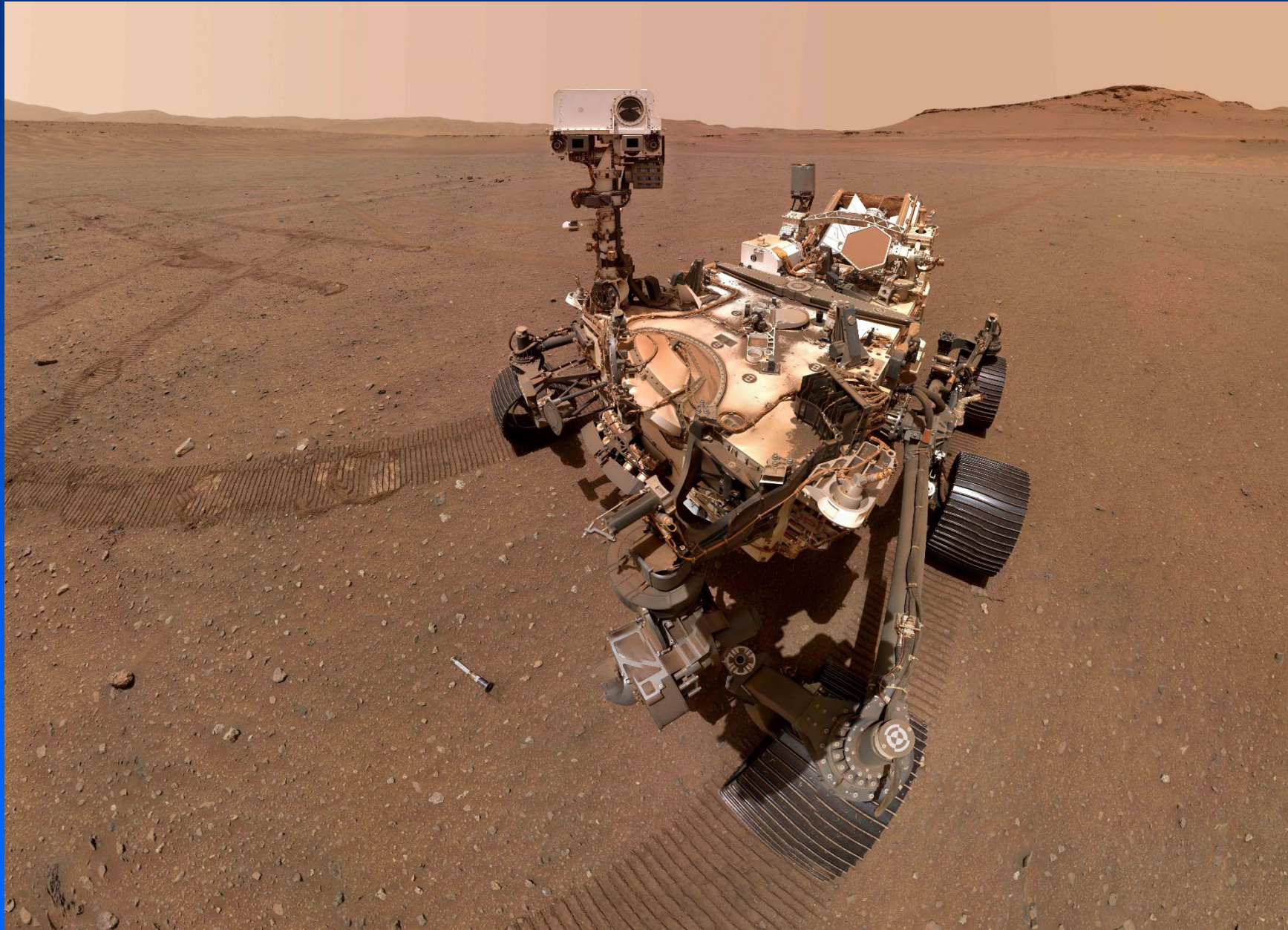


Schuerger et al., 2003, *Icarus* 165, 253-276.

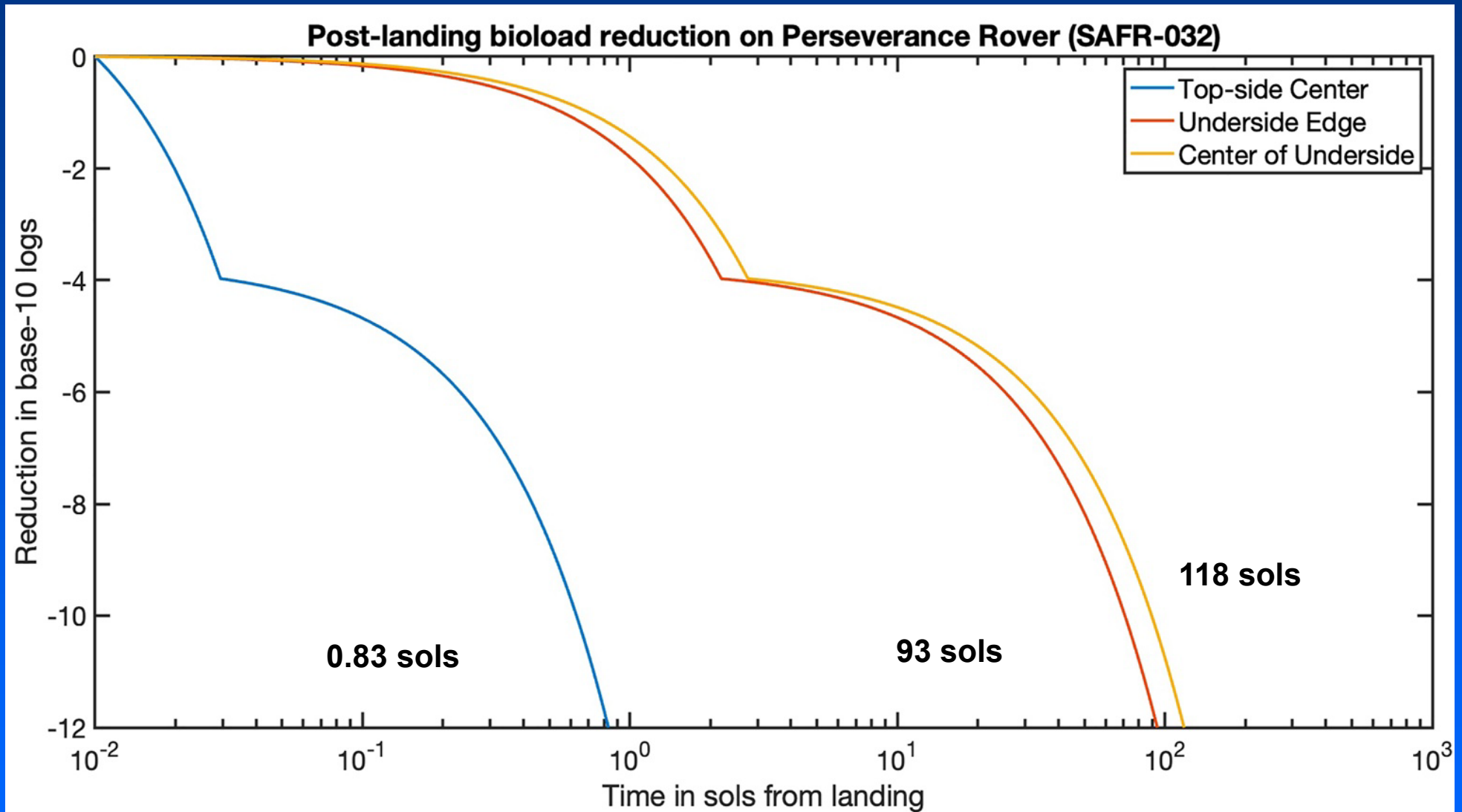
UV Scattering around Spacecraft Structures



Solar UV Dominates Biocidal Effects of 17 Factors

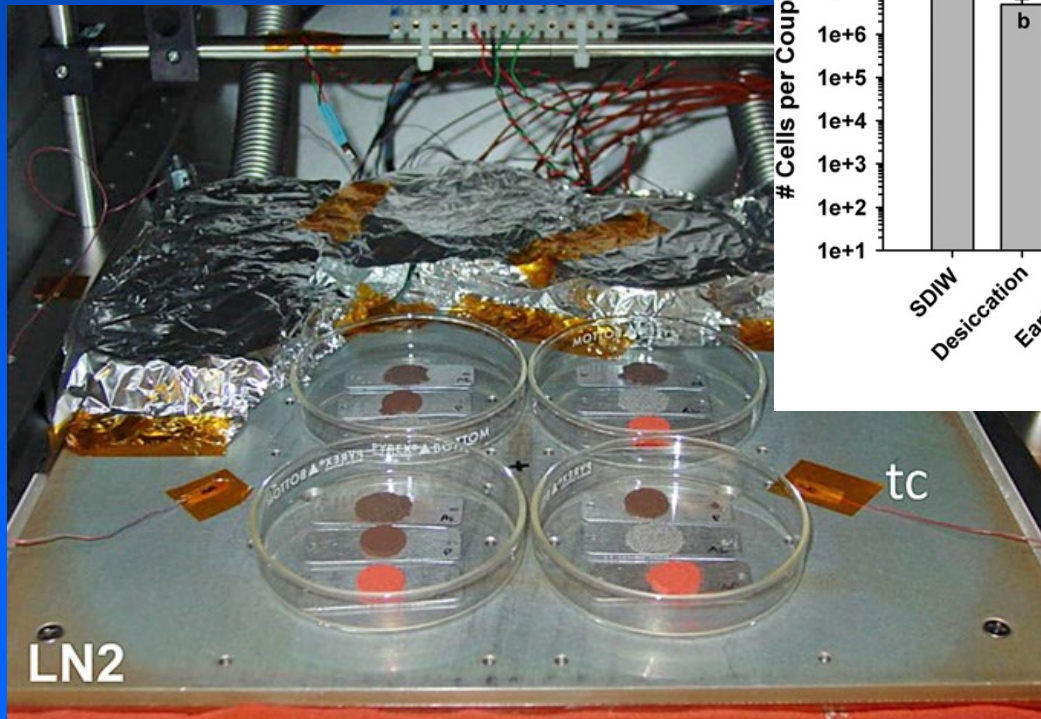
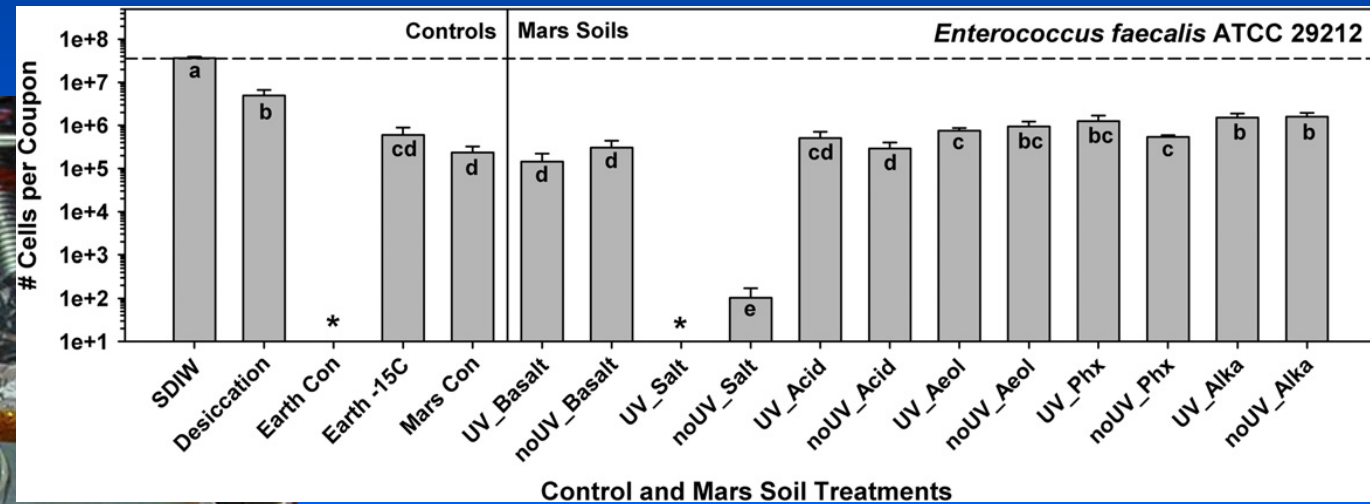
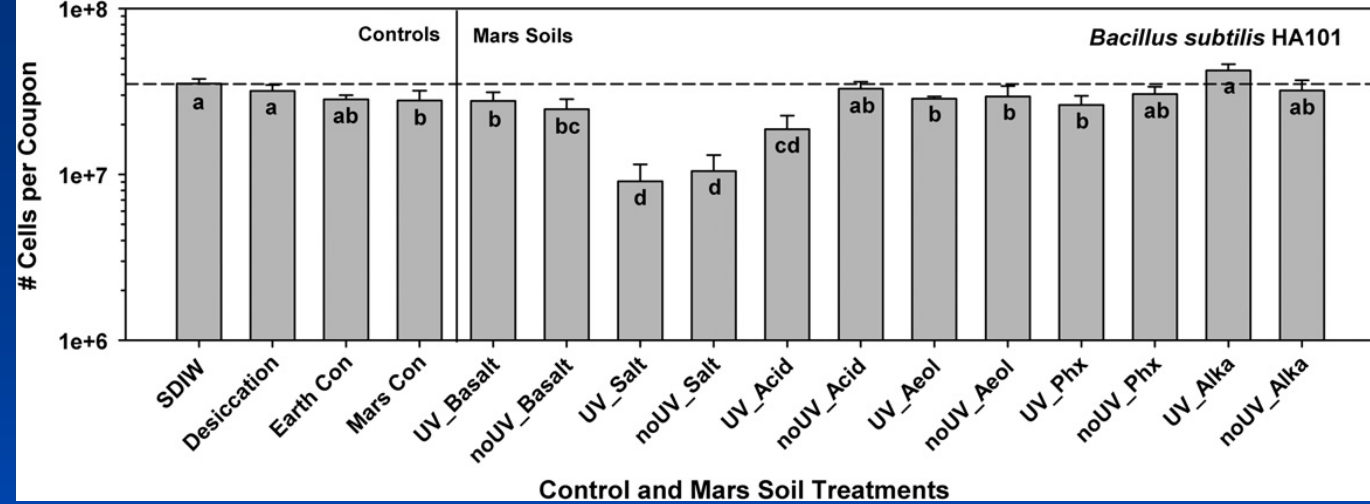


UV Reflectance off of the Martian Terrain



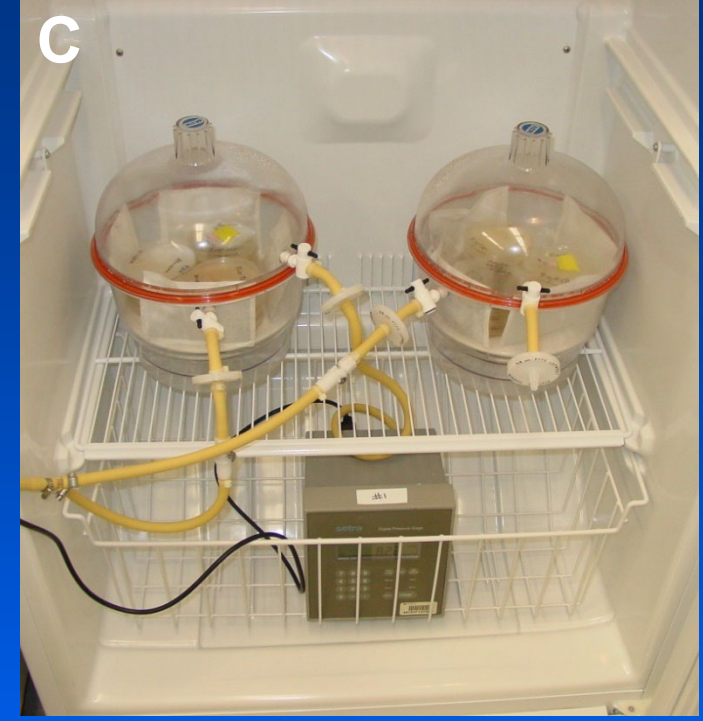
(Schuerger & Moores, 2023, *JGR-Planets*, 128, e2023JE007975.)

Biotoxic Mars Soils



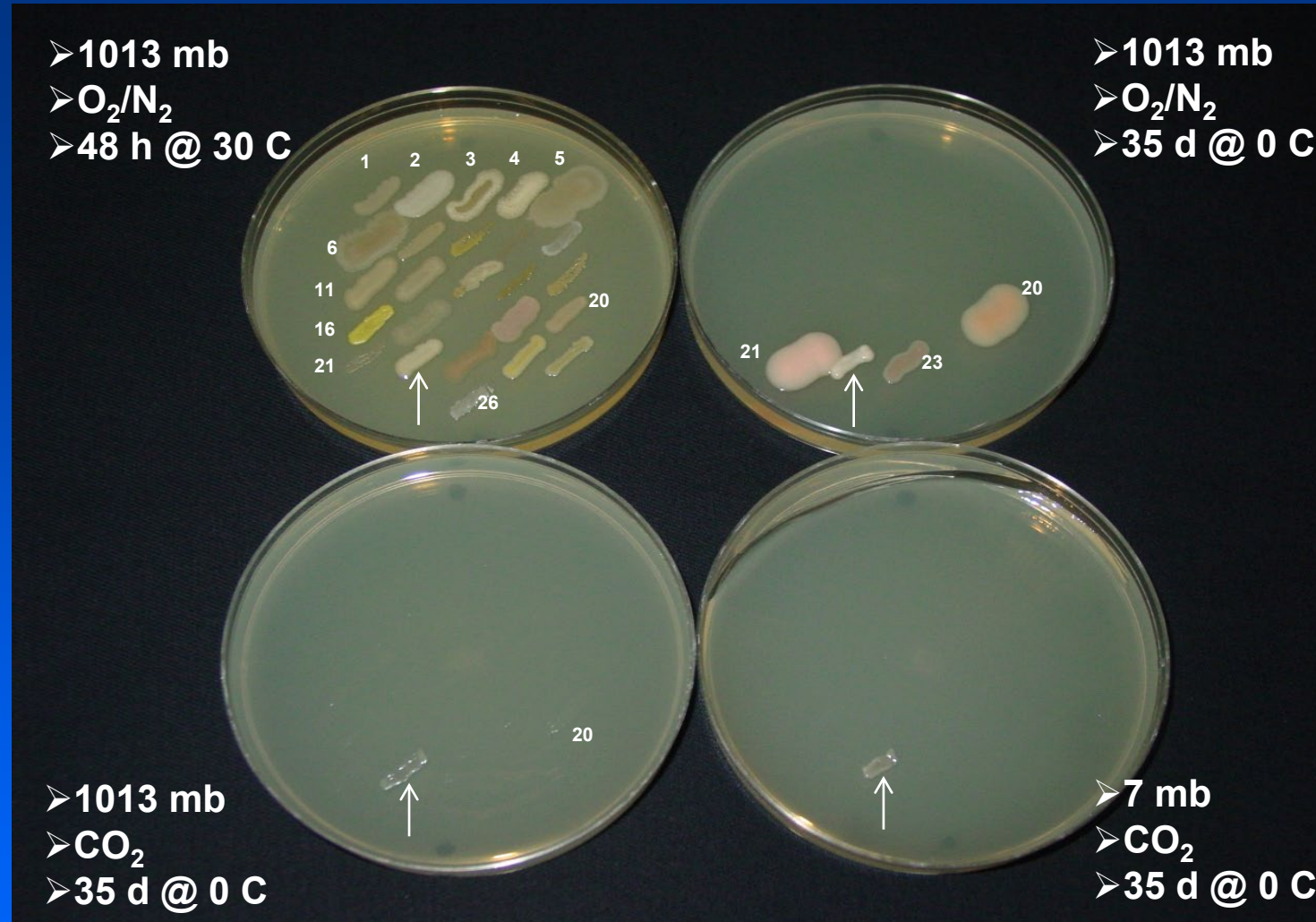
Schuerger et al., 2012, *PSS*, 72, 91-101.

Hypobaric Chambers & Conditions



- 1) TSA = trypticase soy agar; LB = Luria-Bertani broth.
- 2) 1000's of strains of mesophilic & psychophilic bacteria.
- 3) Pressure = 1013, 100, 75, 50, 25, or **7 mbar**.
- 4) Temperature = 30, 25, 15, 10, 5, or **0 °C**.
- 5) Atmosphere = O₂/N₂ or **CO₂**-enriched anoxic atmosphere.

Serratia liquefaciens can grow in 7 mbar, 0 °C, & CO₂-anoxic atmospheres.

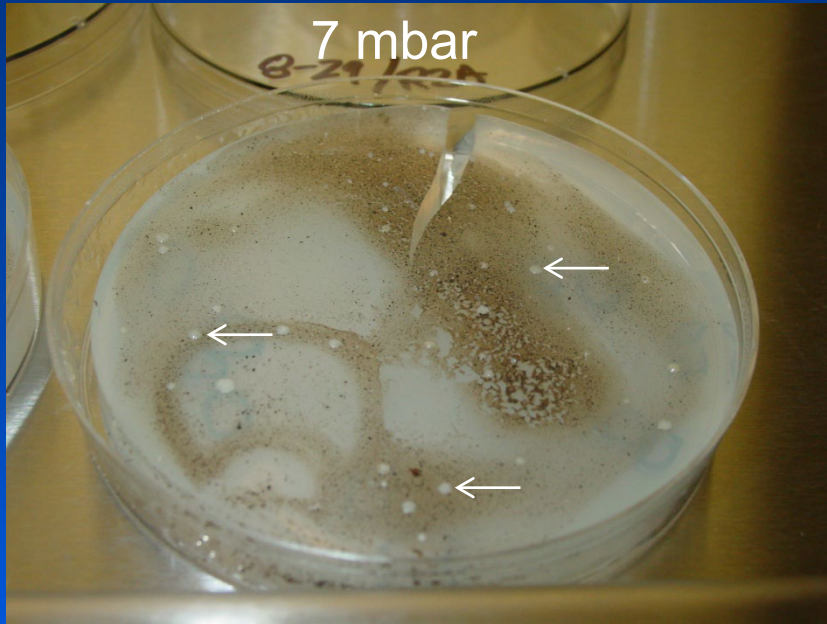


↑ = *Serratia liquefaciens*
ATCC 27592

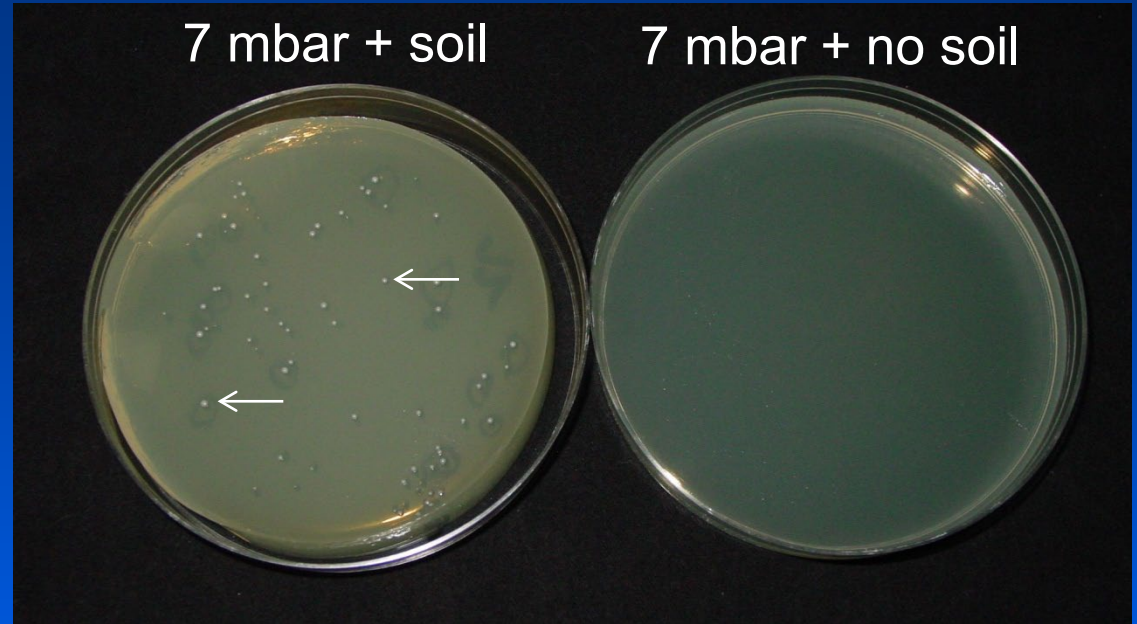
20 = *Pseudomonas fluorescens*
21 = *Psychrobacter cryohalolentis*
23 = *Sporosarcina aquamarina*

Environmental Samples Grown at 7 mbar, 0 °C, and CO₂ Atmosphere

29 species in 10 genera



Colour Lake, Axel Heiberg Island, Canada

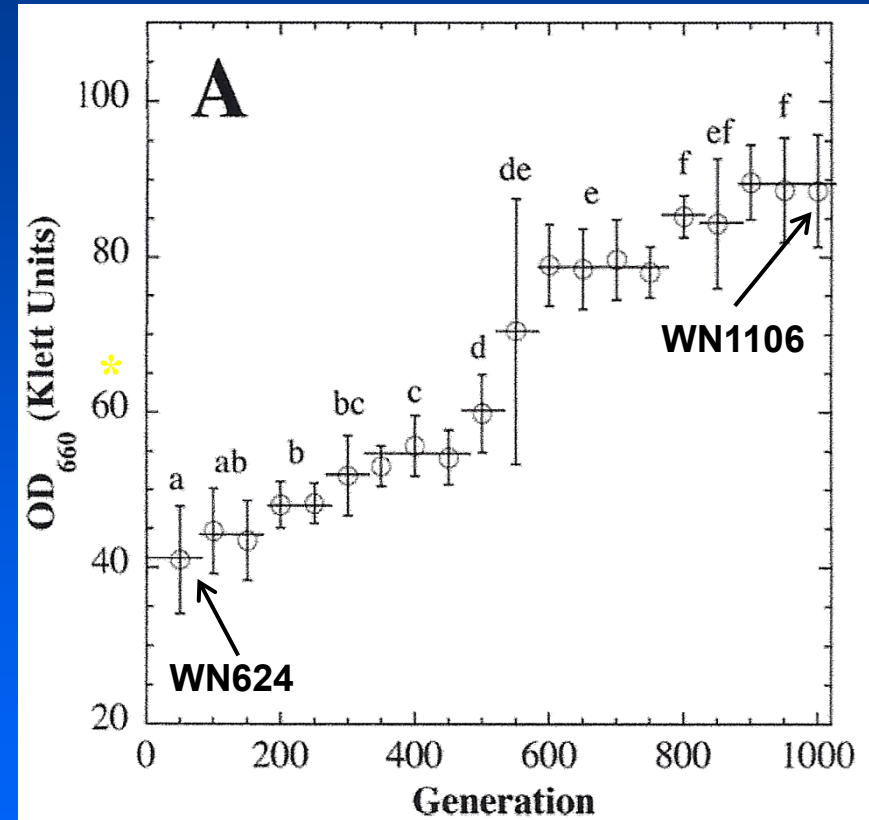


Streptomyces aureus; Colour Lake, arctic soil

- Arctic soils (6 genera)
- Antarctica soils (0)
- Atacama Desert (0)
- Rio Tinto (0)
- Plant leaves (0)
- Sea water (0)
- Siberian permafrost (4)
- Mt. Baker (0)
- PHSF, KSC (0)
- KSC pond water (0)
- KSC forest soil (0)

Adaptation of *Bacillus subtilis* to improved growth at 50 mbar

Adaptation at 50 mbar
(spectinomycin resistance)

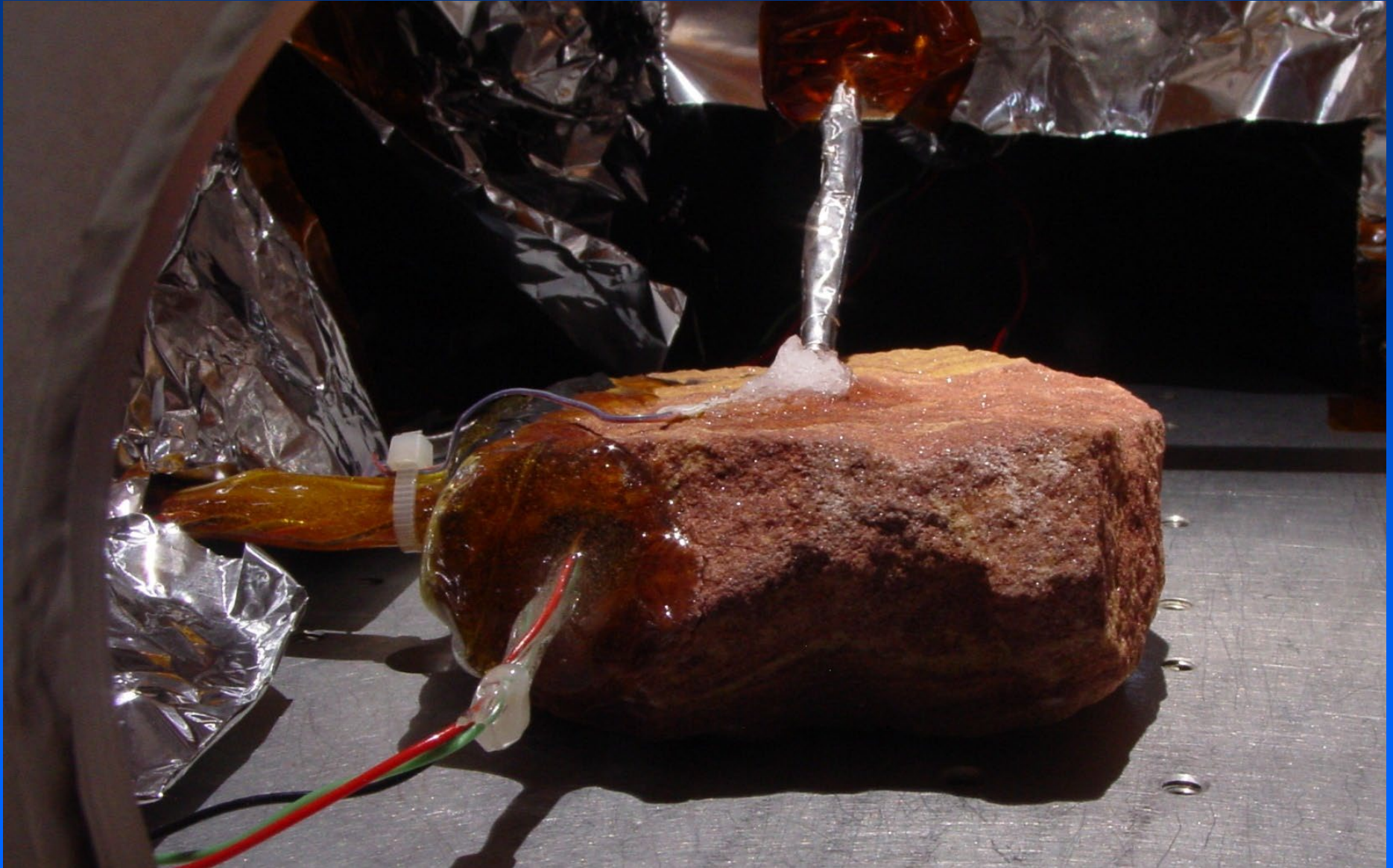


Nicholson et al., 2010, *AEM*, 76:7559-7565.

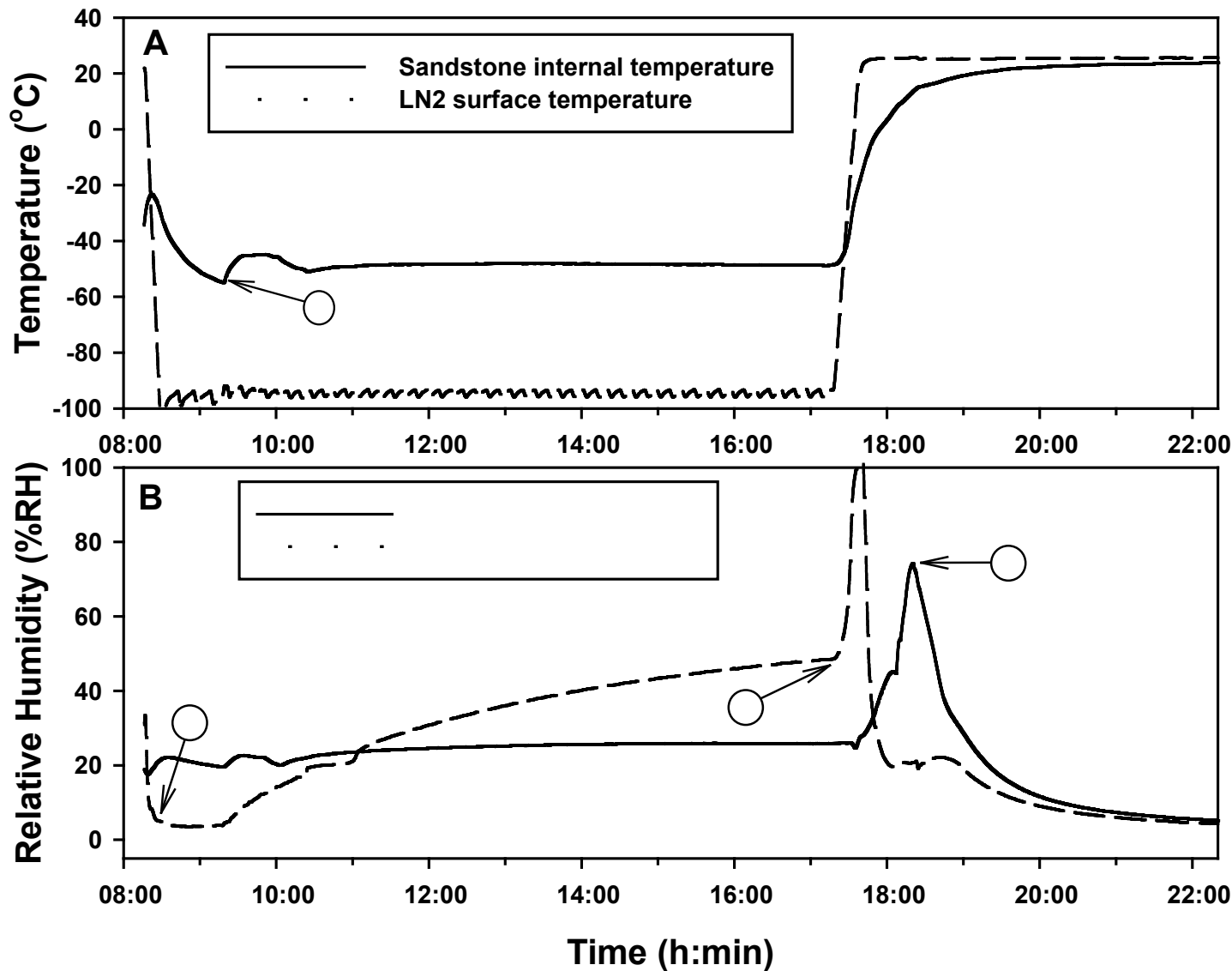
- 60 min depositing frost at -60°C .
- UV turned on at 10:30 am.
- No LN2 heating.



- UV on for 7+ hrs....surface temp at 0 to 5°C.
- LN2 heat for 40 min (5:24 pm).



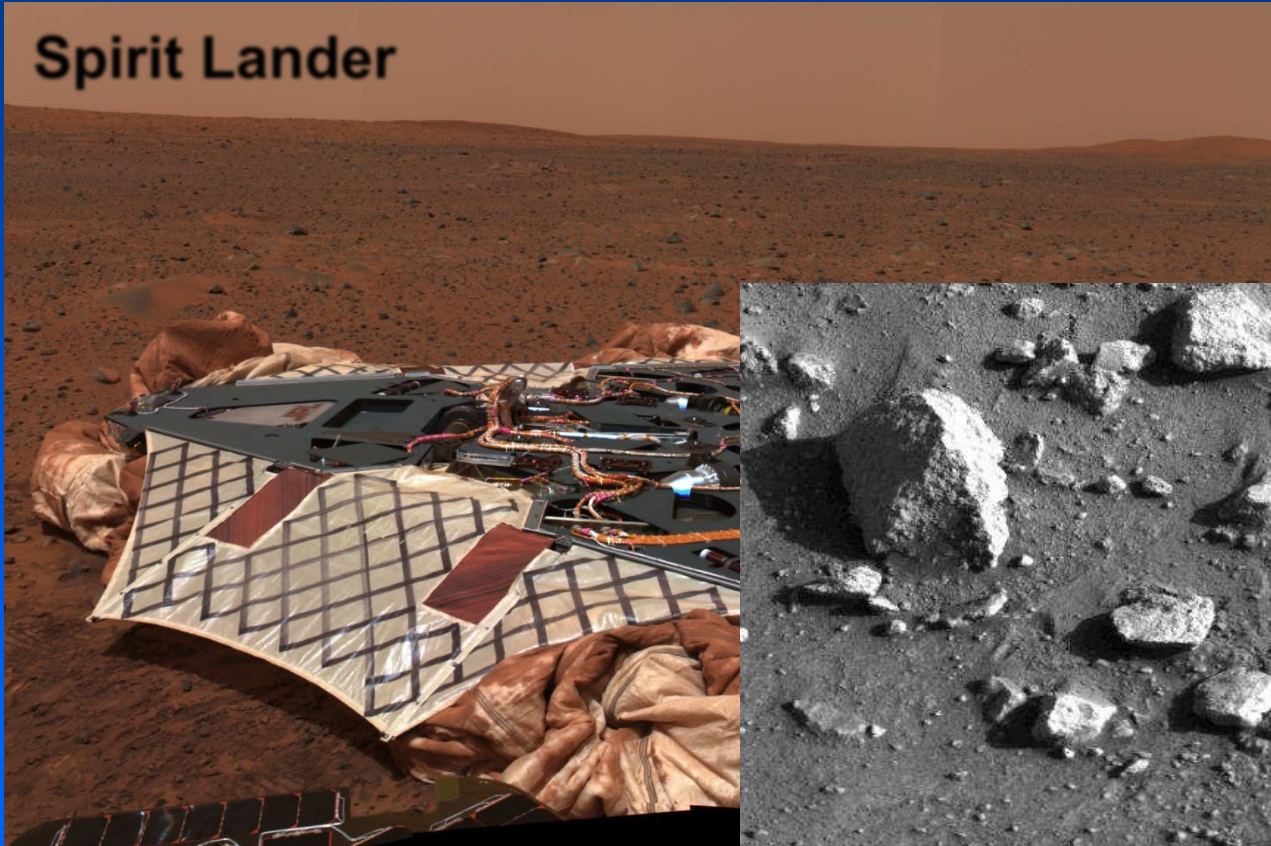
Sandstone...2 - 4 mm frost on upper surface



- 1) Mars simulation.
- 2) UV lamp on.
- 3) LN2 warm-up.
- 4) Peak RH = 70%.

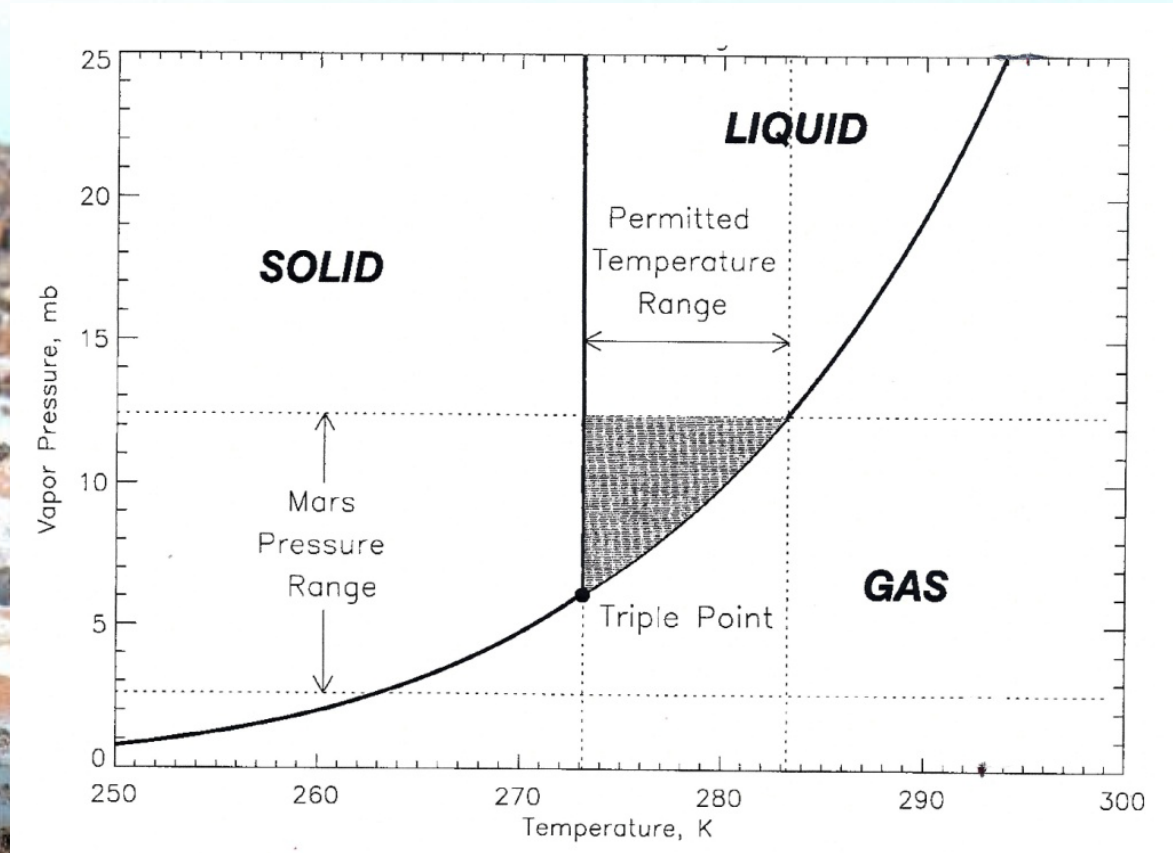
Conclusion: Bacteria on sun-exposed spacecraft surfaces will be inactivated by solar UV within tens of minutes to a few hours on upper surfaces, and 10s to low-100s of sols on undersides of vehicles.

Spirit Lander



Lander Pad 3; Viking 1

Can Earth microbes grow on Mars?...plausible but unlikely.



Haberle et al., 2001, *JGR*, 106(E10).

Viking 2 Lander

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