Postdoc Research

Preservation and Detection of Biosignatures under Simulated Ocean World Surface Conditions

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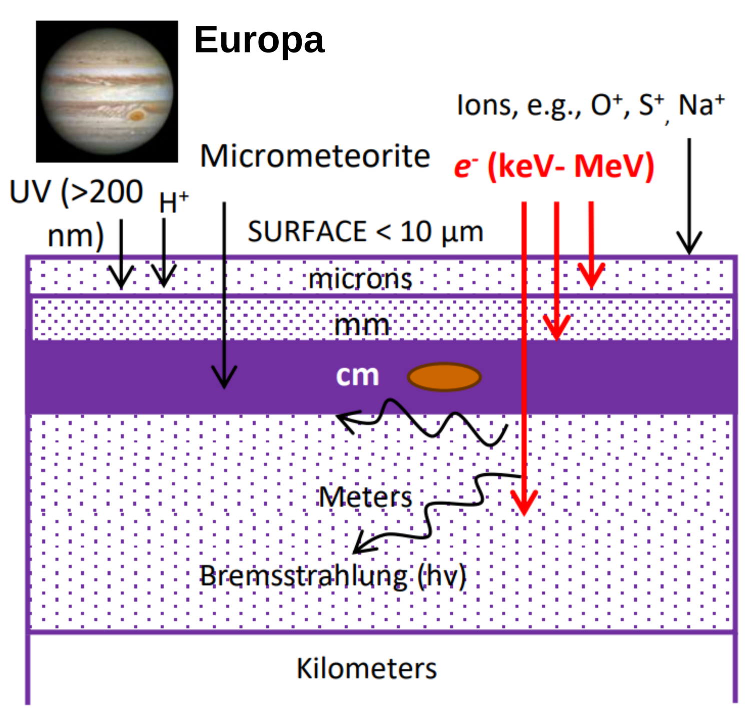
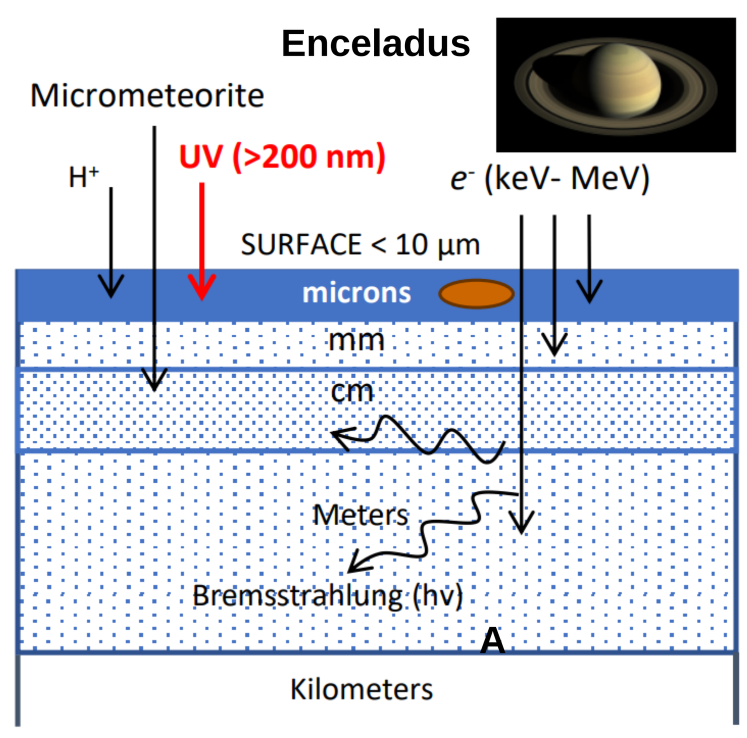
Background & Objectives

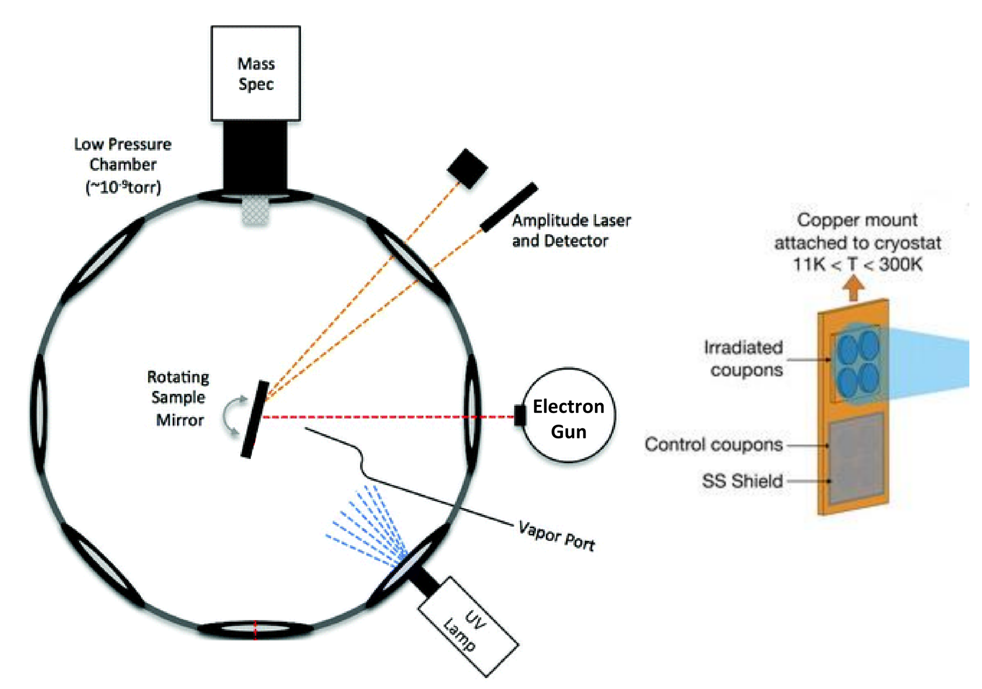
The subsurface oceans of Enceladus and Europa are thought to be some of the best candidates for finding life beyond Earth. Several mechanisms may bring material up from these oceans to the surface, including possible signs of life if they exist. However, one major uncertainty is whether such biosignatures would persist long enough to be detected by future lander missions to these worlds. The goal of this work is to assess the preservation potential of various biosignatures recovered from *B. subtilis* spores exposed to OW surface conditions.

Experimental Approach





cryogenic vacuum chamber



Results

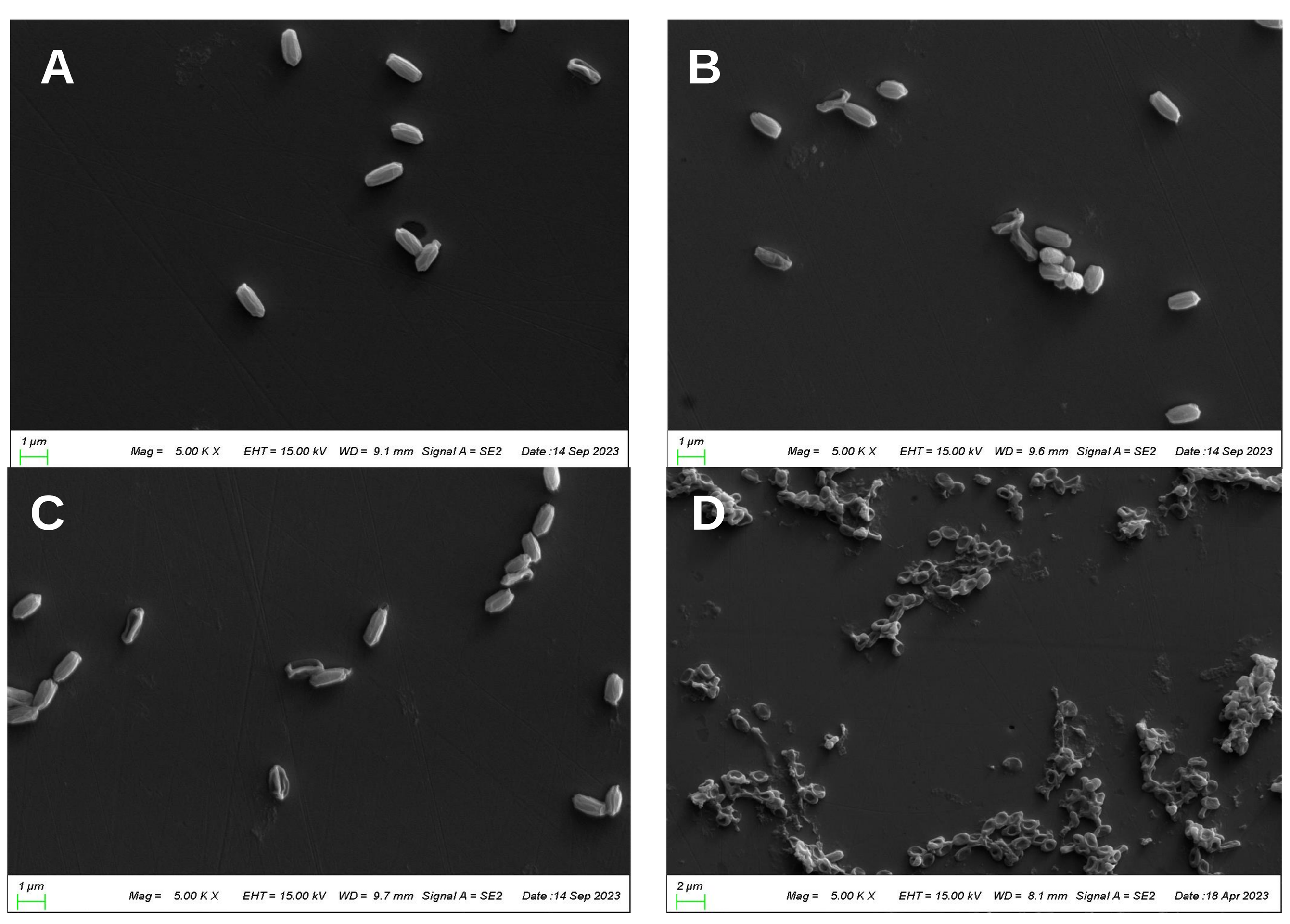


Figure 1: Scanning electron micrographs (SEM) of spores exposed to various treatments. (A) no treatment control, (B) 100K UV-irradiations 3.8 hours no ice, (C) 100K UV-irradiation 3.8 hours with ice, (D) electron-irradiated; 7h at 3 keV, 33.2 µA at 100K.

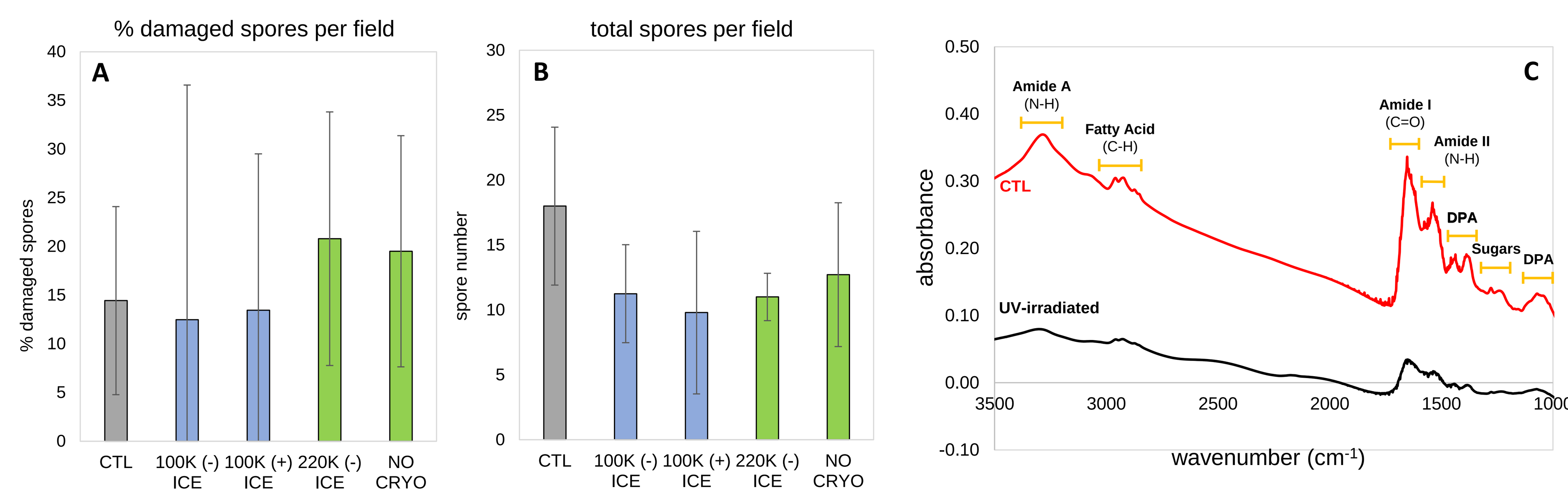
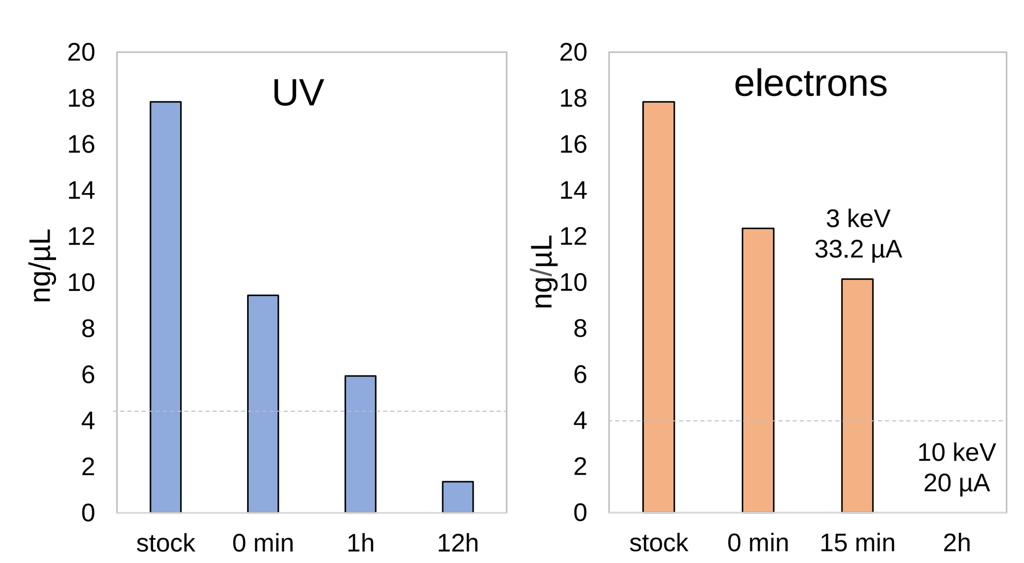


Figure 2: (A) Morphologically intact spores per SEM field (15 random fields at 1000X per treatment); (B) Total spores per field (C) Fourier transform infrared (FTIR) absorbance spectra of UV-irradiated spores.



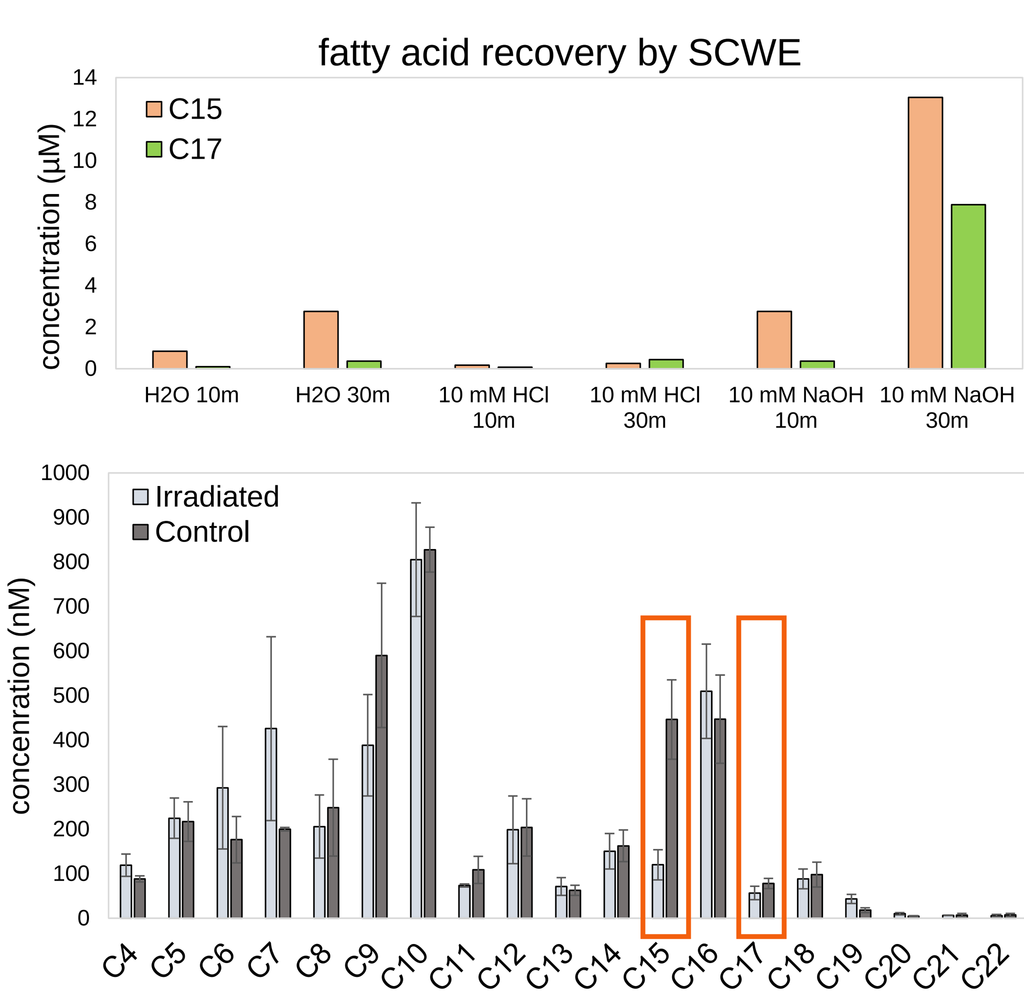


Figure 3: Analysis of extracted chemical biosignatures: (A) Damage to DNA extracted from UV and electron-irradiated spores (absorbance at 260 nm), (B) recovery of fatty acids by sub-critical water extraction (SCWE), (C Saturated fatty acid distributions of control and electron-irradiated spores (10 keV, 20 µA for 2h at RT).

Significance & Future Work

Previous work showed that spores are rapidly inactivated under simulated OW surface conditions, they may leave behind biosignatures that are preserved long enough to be detected. Spore morphology and native chemistry appears to be preserved over longer timescales than extracted chemical biosignatures. These results will guide planning for future missions to OW surfaces and planetary protection measures. Ongoing work includes carrying out irradiations to simulate geologically relevant OW timescales and analysing effects on DNA, fatty acids, and amino acids.

Relevant Publications:

Fayolle, Edith C., et al. "Viability of Bacillus subtilis spores exposed to ultraviolet light at ocean world surface temperatures." *Astrobiology* 20.7 (2020): 889-896.

Noell, Aaron C., et al. "Spectroscopy and viability of Bacillus subtilis spores after ultraviolet irradiation: implications for the detection of potential bacterial life on Europa." *Astrobiology* 15.1 (2015): 20-31.

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