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Microbial survival at Ocean World relevant interfaces

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Icy worlds, such as Europa and Enceladus, have been considered one of the most compelling habitats for extraterrestrial life. On these icy moons, interfaces, including the sub-ice ocean and the seafloor, have been hypothesized as likely habitats suitable for life. Environmental factors such as low water activity, low temperature, and high salinity impact the habitability of ice-brine interfaces. The survival mechanisms of extremophilic life on Earth may be used as an analog for how life may be possible in ice-brine Ocean World environments.

The production of biologically synthesized surfactants (biosurfactants) is investigated here as a survival mechanism potentially relevant to Ocean Worlds. Biosurfactants (BS) are metabolites with amphiphilic properties – identified in more than half of microorganisms isolated from polar sediment communities – that are known to reduce fluid surface tension and increase substrate solubility, cell communication, cell motility, and cell attachment/detachment [1].

The research to be presented focuses on the effect of BS production on the survivability of an Antarctic bacterial isolate (PL17) under stressors relevant to Ocean Worlds (e.g. high salinity, repeated freeze cycles, varied pH, UV light). Conditions that inhibit growth of PL17 have been screened and subsequently assessed both with and without the addition of the organism's own BS to determine the impact of the BS on the proliferation and respiration of both the wild-type organism and a BS-deficient mutant. Survival analyses of cells undergoing both freeze-thaw cycling and high (roughly double seawater) salinities have shown significant changes in colony forming unit counts between the +BS and -BS treatments, with further experimental work and data analysis in process for other stressors. This work captures not only the change in cellular survival, but also the associated changes in the transcriptome and production of metabolites. Additionally, the wild type and mutant organism have been grown with and without BS within a simulated Ocean World ice-brine interface to determine whether the presence of BS impacts the localization of the organism.

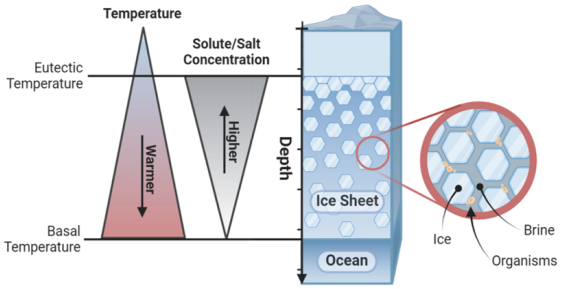

Figure 1. Summarized icy world system highlighting the variation of temperature and solute concentration across an ice shell and the potential habitable zones within (e.g., ice-brine interface).

References:

[1] A. Perfumo, I. M. Banat, and R. Marchant, "Going Green and Cold: Biosurfactants from Low-Temperature Environments to Biotechnology Applications," Mar. 01, 2018, Elsevier Ltd. doi: 10.1016/j.tibtech.2017.10.016.