Microbial Survival in Brines and its Relevance to the Near-Surface Habitability of Mars

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Remote sensing and in-situ measurements have detected a global distribution of chloride and perchlorate salts on the Martian surface (Keller et al., 2006; Clark and Kounaves, 2015). These highly hygroscopic salts, such as calcium perchlorate, can absorb water from the thin Martian atmosphere and temporally form stable liquid solutions (Nuding et al., 2014; Heinz et al., 2016). However, the habitability of these brines remains unclear; a knowledge gap we attempt to close with our research.

For this purpose we have been investigating growth and survival of the halo- and cryotolerant bacterial strain *Planococcus halocryophilus* Or1 in three different ways:

(1) We determined their maximum salt concentrations suitable for growth for six chloride and perchlorate salts at 25°C and 4°C.

(2) We investigated the survivability of *P. halocryophilus* in brines of the same salts at eutectic concentrations at temperatures ranging from -30°C to +25°C (Heinz et al., 2018).

(3) We tested correlations between the death rates in eutectic brines and physicochemical parameters like water activity, ionic strength and hydrogen bond lengths between anions and water molecules of their hydration shells.

Our results show remarkable halotolerances of *P. halocryophilus* to all investigated salts. For example, we noted an increase in tolerance of *P. halocryophilus* to $CaCl_2$ by lowering the incubation temperature from 25°C to 4°C. Furthermore, we found the highest tolerance to $NaClO_4$ (1.1 M) reported to date. During growth in salt-rich media the cells showed several microscopic (e.g. cell clustering, encrustation) and macroscopic (changes in cell colony morphologies) salt stress responses. At eutectic salt concentrations no growth can be observed. However, the bacterial survival can be increased substantially by lowering the temperatures to subzero values (Heinz et al., 2018).

We found evidence that the death rates in these eutectic brines correlate most with the hydration bond length between anions and water molecules suggesting an important role of size and strength of hydration shells on the toxicity of anions in briny solutions. A correlation was also found with water activity, but not with ionic strength.

These findings have important influence on enhancing our knowledge of the habitability of cryobrines on Mars and other planetary bodies and are particularly relevant to microbial survival mechanisms that utilize the hygroscopic properties of salts including the process of deliquescence.

References:

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