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Development of an environmental chamber for studying the brines of the Mars Phoenix landing site

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Renno et al. [2009] presented physical and thermodynamical evidence that liquid brines were observed at the Phoenix landing site on Mars' arctic, while Zorzano et al. [2009] showed experimentally that liquid brines could form by deliquescence at the Phoenix landing site. Renno et al. [2009] suggests that the thermodynamics of freeze-thaw cycles could produce brine pockets almost anywhere on Mars, where ground ice is present near the surface. The presence of liquid brines on Mars has important implications for its habitability because many terrestrial microbes thrive in brines [Boetius and Joye, 2009].

We describe the development of an environmental chamber to test the hypothesis that pockets of liquid brines are common on Mars. The chamber consists of a cryogenic freezer containing a low-pressure chamber filled with simulated Martian air. This chamber is used to test the hypothesis that salts present in the Martian soil can deliquesce and form concentrated brine pockets during recurring freeze-thaw cycles. In a proof-of-concept test, salts are placed on a sample holder, its temperature is then adjusted to desired values, and the chamber's humidity is increased slowly while deliquescence is verified with visible and infrared (IR) techniques. From this, the environmental conditions (temperature, pressure, and humidity) necessary for the deliquescence of salts on Mars are determined. More realistic tests use soil analogs and water ice, cycled through simulated Martian days, to study the evolution of brine pockets over time.

Our chamber was specifically designed to simulate diurnal and seasonal temperature and moisture cycles in the shallow Martian subsurface. During these cycles, soil wetness, density and brine content are measured. The wetness of soil simulants are measured with a microwave resonator developed at the University of Michigan [Sarabandi and Li, 1997; Kendra et al., 1994] and available in our laboratory. Following the experiments, MRI is used to map brine pockets in the test samples. As these brine pockets are potentially habitable, it is foreseen that this chamber will be used for exobiology experiments in the future.

References

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