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MATERIALS AND STRUCTURES SYMPOSIUM (C2)
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THERMAL MAPPING AND TRENDS OF MARS ANALOG MATERIALS IN SAMPLE ACQUISITION OPERATIONS USING EXPERIMENTATION AND MODELS

Abstract

The effects of atmosphere, ambient temperature, and geologic material were studied experimentally and using computer simulation to determine the heating undergone by Mars rocks during rover sampling operations. Tests were performed on five well-characterized and/or Mars analog materials: 120 MPa Saddleback Basalt, travertine, kaolinite, Indiana Limestone, and water ice. Twenty-seven tests were conducted to 5.5 cm depth with a Mars Sample Return (MSR) prototype coring drill in a 3.5 m3 vacuum chamber to gather thermal profiles within the rocks during simulated sampling operations. Five embedded sensors within the rocks provided this data while verifying the accuracy of a computer model able to predict the entire thermal profile of a rock during a sampling operation. This model can be used to schedule power levels and periods of rest during actual sample acquisition processes to avoid reaching maximum temperature limits. On Mars, a priori thermal maps are necessary to ensure that sample operations are planned in order to avoid the evolution of volatile materials, such as water ice, in order to preserve the science content of returned samples. In addition, controlling temperatures prevents vapor deposition of sublimated ice which could permanently bind a bit into the borehole.

Other observations were made during the experimental suite. Lower starting temperature (77 K) lead to higher rock UCS, and ultimately more heat input by the drill during drilling. In kaolinite, despite reduced friction at lower pressures and dryer air, penetration rates slowed and heat input increased by 50