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SPACE EXPLORATION SYMPOSIUM (A3)
Mars Exploration – Part 1 (3A)

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THERMAL MODELING AND EXPERIMENTATION ON MARS ROCK ANALOGS TO PLAN ROVER SAMPLING OPERATIONS

Abstract

The ability to predict thermal profiles in rock or soil formations during coring or drilling operations is critical in sample acquisition planning in order to avoid excessive temperature increases. In addition to damaging the scientific content of samples, sufficient rises in temperature could cause sublimation of any ice contained in the geologic formation. This vapor could then refreeze onto cooler areas of the bit and cause the bit to become permanently lodged in the formation, putting the mission at risk. Four terrestrial analog substances, identified by JPL scientists as having similar properties to substances likely to be sampled on Mars, were subjected to a series of simulated rover drilling tests in a 6.0 torr carbon dioxide environment at -50 C to produce a library of thermal histories which reveal characteristics of the rocks' responses to heating. The set of analogs consisted of kaolinite, a soft, sedimentary phyllosilicate with an unconfined compressive strength (UCS) of 2 MPa and in a class of materials which could provide insight into Mars' watery past; Saddleback basalt (UCS 120 MPa) and Cima vesicular basalt (USC 45 MPa), igneous rocks representing substances which could reveal clues about Mars' ancient volcanism, the latter also selected because of its likelihood to create strong vibrations during sample acquisition; and a volcanic breccia, selected for its inhomogeneity. To perform all tests, the Honeybee Robotics SASSI drill, a prototype for a Mars sample return (MSR) mission, was used. The thermal profiles from sensors mounted on and within the formations match predictions produced by a computer simulation specifically designed to model thermal environments during coring and drilling. A collection of experimental data from testing of Mars analog rocks and an accurate thermal model capable of predicting thermal histories are essential in ensuring that geologic samples for in situ study or return to Earth are acquired without alteration in a manner that does not place the rover's sampling instruments at risk.