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Spectral Monitoring of Volatiles During Drilling into Frozen Lunar Simulant

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Abstract Text:

NASA's Resource Prospector (RP) project intends to characterize the 3D distribution of volatiles in permanently shadowed regions at the lunar poles. One RP remote sensing instrument is a near-infrared spectrometer with an associated camera and radiometer, called the Near-InfraRed Volatile Spectrometer System (NIRVSS). In May 2016, NIRVSS, a Honeybee Robotics drill, and an Inficon mass spectrometer were placed in a vacuum chamber at Glenn Research Center. Also inside was a tube (1.2 m high x 25 cm diameter) filled with lunar simulant NU-LHT-3M, initially doped with a homogeneous water abundance of ~5%, chilled to cryogenic temperatures and exposed to a vacuum (~10e-6 Torr).

During drilling, the NIRVSS instruments observed the cuttings pile as subsurface materials were emplaced on the surface. Spectral features associated with water ice, near 2000 and 3000 nm, were measured by the spectrometer during drilling. The spectral data documents development of a desiccated soil layer in the tube down to ~25-30 cm (confirmed by post-test soil analyses), formed during the initial pump down to vacuum. Drilling occurred in 10 cm segments, with the drill stem extracted and flutes brushed after each 10 cm depth. One exception to this was the 40 cm depth segment where the soil was delivered to a sample capture mechanism, and sealed for post-test analyses. To ~30 cm depth the greatest 2000 and 3000 nm signatures were associated with brushing of the drill flutes above the surface. At depths >40 cm the strongest ice signatures were associated with the drill clearing soil from the existing hole, or beginning to encounter new material. For these greater depths, brushing the flutes after extraction produced much weaker ice signatures than for shallower depths. This suggests that the soil may remain trapped in the exit funnel and is not emplaced on the surface. After each event creating strong ice signatures, these signatures decreased to near background levels in 5 minutes or less, due to surface exposure to vacuum.