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Crowd-funding, tool tests to clear way for space resource collection

by Kurt Sacksteder

*The **Space Resources Technical Committee** advocates affordable, sustainable human space exploration using non-terrestrial natural resources to supply propulsion, power, life-support consumables and manufacturing materials.*

Along with lunar, planetary and asteroid scientists, space resource advocates are conceiving new exploration approaches and advanced technology concepts under a paradigm in which scientific advancement helps to identify resources, and resources enable scientific exploration.

NASA's **Life in the Atacama**, or LITA, team is making plans to return to the Chilean desert in 2015 to conduct more tests of sample-collection technologies. In 2013, Honeybee Robotics deployed a fully robotic 1-meter-long drill in the Atacama on a Carnegie Mellon University-designed rover called Zoë. The 10-kilogram LITA drill captured samples from target depths and delivered them to a carousel for analysis by instruments that included a Raman spectrometer. In 2014, Honeybee also tested the LITA drill in the Mojave Desert. LITA is part of NASA's Astrobiology Science and Technology for Exploring Planets program.

Deltion Innovations Ltd., a maker of **space mining** equipment, moved from a location in Sudbury, Ontario, to a newly acquired 28,000-square-foot facility located approximately 30 kilometers away in Capreol, Ontario. This move will allow the company to expand its labor force as the need arises over the next couple of years.

Deltion and the Colorado School of Mines are planning the May 2015 Planetary and Terrestrial Mining Sciences Symposium/Space Resources Roundtable in conjunction with the Canadian Institute of Mining Annual Convention, with the intention of promoting space resource utilization to the terrestrial mining industry. The institute has over 14,000 members from all sectors of the mining and petroleum industries.

Researchers from the Center for Space Exploration Technologies Research at the University of Texas at El Paso investigated extracting water from **lunar polar regolith** using a concept, proposed by ExoTerra Resource, involving beaming power from solar concentrators to regolith in shadowed craters. The researchers developed regolith heat-transfer models and validated their modeling using laser beams to simulate concentrated solar power.

Planetary Resources Inc.'s demonstration satellite, **Arkyd 3,** was among the payloads destroyed when an Antares rocket failed in October. The plan was to deploy the satellite from the International Space Station's Japanese airlock to test avionics and failure points for PRI's Kickstarter-funded Arkyd telescope, which the company describes as the "first publicly accessible space telescope." PRI said on its website that it will "live to fly another day" and continue work on its next test satellite, Arkyd 6. PRI also signed a Space Act Agreement with NASA to create a crowd-sourced algorithm challenge called Asteroid Data Hunters, and partnered with Zooniverse to launch Asteroid Zoo, a web-based asteroid detection challenge.

At NASA's Glenn Research Center, the **Mars Atmospheric Chemistry System** was improved to add low-temperature capability, complementing the high-fidelity simulation of Mars atmosphere composition, dust, and pressure environment for in situ resource utilization component testing. The Glenn VF-13 facility commissioned a removable cold wall, in addition to the cryogenic soil bin, making it the largest available dirty thermal-vacuum facility. This year, hardware concepts and instrumentation for subsurface soil extraction and volatile retention were tested in lunar thermal/vacuum environment.

Members of the Space Resources Technical Committee engaged in outreach and unfunded, interest-driven technology development. Matthew Cross, a Ph.D. student at the University of Western Ontario, led preschoolers to demonstrate lunar impact cratering and lunar resource mining using flour as regolith, golf balls as meteors and marshmallows as buried resources. Doug Plata, author of the Cis-lunar One plan for sustainable space development, performed a demonstration of hydrogen-oxygen propellant production from a soil/water mixture based on moisture ratios measured by LCROSS — the Lunar Crater Observation and Sensing Satellite — plus microwave water extraction and electrolysis reactant separations. Representing NASA Glenn, I presented concepts for propellant production using Mars atmosphere and water resources to a statewide Ohio STEM program emphasizing innovation and entrepreneurism among high school students.

Committee members participated in in-situ-resource-utilization-related updates to the 2011 NASA Office of Chief Technologist Technology Roadmaps. The roadmaps help organize the broad spectrum of technology development investment options to enable and enhance more affordable human and robotic exploration of space.

Carnegie Mellon's Zoë rover.

Carnegie Mellon University

Honeybee Robotics

LITA drills in the Atacama Desert.