RESOLVE LUNAR ICE/VOLATILE PAYLOAD DEVELOPMENT AND FIELD TEST STATUS.
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Introduction: Understanding the form, distribution, and content of water/ice and other volatiles at the lunar poles can have a profound effect on the scientific understanding of the Moon and solar system evolution, and on plans for utilizing the resources on the Moon for sustained human exploration and the commercial development of space. While orbital remote sensing and surface impact data has been obtained from lunar scientific spacecraft on the potential presence and distribution of water/ice on the Moon, the data collected provides only an initial understanding of its form and distribution which must be further refined. Since 2005, the National Aeronautics and Space Administration (NASA) and the Canadian Space Agency (CSA) have cooperated in developing an experiment package that could provide 'ground truth' measurements of water/ice and other volatiles at the lunar poles as well as demonstrate the feasibility of extracting oxygen from lunar regolith.

RESOLVE Overview: The Regolith & Environment Science and Oxygen & Lunar Volatile Extraction (RESOLVE) is a rover-based experiment that includes neutron and near infrared spectrometers to locate hydrogen-sources and water, a drilling system to collect samples down to one meter below the surface, and a sample analysis oven with a gas chromatograph/mass spectrometer to heat and analyze water and other volatiles released from subsurface samples. The same oven can be heated to 900 ºC with hydrogen gas to extract oxygen from iron-oxide minerals in the regolith. From 2005 to 2010, two generations of RESOLVE prototypes were built and tested, along with performing tests of RESOLVE on a rover at an analogue site in Hawaii in Nov. 2008 and Feb. 2010.

RESOLVE Design Reference Mission (DRM): In order to design the 3rd generation RESOLVE, a design reference mission (DRM) study was performed. Sites for the DRM had to meet four selection criteria: 1) high hydrogen concentrations, 2) good ice stability, 3) visibility from Earth so a relay satellite is not required to perform the mission, and 4) brief periods of sunlight to allow solar power to be utilized. Data from four instruments on LRO (LEND, DIVINER, LOLA, and LROC) were used in the study. Design requirements for RESOLVE are based on a 5-7 day sunlit mission near Cabeus crater.

RESOLVE 3rd Generation Flight Prototype: To meet mission DRM requirements, the 3rd Generation of the RESOLVE is being designed to operate both in sunlight as well as brief periods of shadowing (<100 K) and to perform 3 to 5 one-meter drill core sample collection and analyses operations in a 5 to 7 day period over a 1 to 3 km traverse. The 3rd Gen RESOLVE unit is being designed and built in two Phases. Phase I is a flight mass/power unit for lunar polar mission simulation analogue testing in July 2012, and Phase II is a flight mass/power unit for lunar environment testing in 2014.

Lunar Polar Mission Simulation: To validate both the design of the 3rd generation RESOLVE unit as well as the lunar polar RESOLVE DRM, an analogue field test mission simulation was performed in July 2012. The purpose was to demonstrate: i) integration of all the hardware necessary for flight on a single rover, ii) integrated operations of the RESOLVE and rover including roving/scanning, drilling/sample transfer, and sample processing/volatile measurement, iii) all mission operations and timelines to validate a short duration lunar mission, and iv) mission command and control with lunar time delays and bandwidth limitations.

To make the mission simulation as realistic as possible, polyethylene sheets were used to simulate ice/water concentrations and a mockup lander was utilized to 'deliver' the RESOLVE/rover to the mission start location and provide communication, situational awareness, and relative navigation to the RESOLVE/rover mission team. All operations were performed remotely with either the main RESOLVE/rover mission team near the test site, or by personnel at control centers at NASA Johnson and Kennedy Space Centers, CSA, or science support from NASA Ames Research Center using only data provided by the rover or mockup lander.

Before the field test, Category 1 (mandatory) to 4 (goals) objectives based on the RESOLVE lunar DRM were established. At the completion of the analogue mission simulation, almost all of the Category 1, 2, and 3 objectives were accomplished and 2 of 5 Category 4 objectives were accomplished.

Next Step in RESOLVE Development: With the completion of the Phase I RESOLVE buildup and mission simulation in Hawaii, the RESOLVE team is now focusing on Phase II development of the lunar vacuum/environment compatible flight prototype. Further testing of the Phase I RESOLVE unit will also be performed to provide more lessons learned going into Phase II. Lunar environment testing is planned for August, 2014.