Resource Prospector: A lunar volatiles prospecting and ISRU demonstration mission A. Colaprete[1], R. Elphic[1], Jerry Sanders[2], Jackie Quinn[3], Bill Larson[3], M. Picard[4], [1]NASA Ames Research Center, Moffett Field, CA, [2]NASA Johnson Space Center, Houston, TX, [3]NASA Kennedy Space Center, FL, [4]Candian Space Center, Québec, Canada.

Introduction: Over the last decade a wealth of new observations of the moon have demonstrated a lunar water system dramatically more complex and rich than was deduced following the Apollo era. Observation from the Lunar Prospector Neutron Spectrometer (LPNS) revealed enhancements of hydrogen near the lunar poles. This observation has since been confirmed by the Lunar Reconnaissance Orbiter (LRO) Lunar Exploration Neutron Detector (LEND) instrument. Observations from the Lunar Crater Observation and Sensing Satellite (LCROSS) mission, which impacted into Cabeus, a shadowed crater showing enhancements of hydrogen, showed that at least some of the hydrogen enhancement was in the form of water ice and molecular hydrogen (H2). Other volatiles were also observed in the LCROSS impact cloud, including CO2, CO, an H2S. These volatiles, and in particular water, have the potential to be a valuable or enabling resource for future exploration. In large part due to these new findings, the NASA Human Exploration and Operations Mission Directorate (HEOMD) has selected a lunar volatiles prospecting mission for a concept study and potential flight in CY2018. The mission includes the RESOLVE (Regolith and Environment Science and Oxygen & Lunar Volatile Extraction) payload, rover (provided by the Canadian Space Agency (CSA), and a lander (currently lead by MFSC and JSC). RESOLVE is a rover-borne payload that (1) can locate near subsurface volatiles, (2) excavate and analyze samples of the volatile-bearing regolith, and (3) demonstrate the form, extractability and usefulness of the materials.

Real-time Prospecting and Combined Instrument Science: Temperature models and orbital data suggest near surface volatile concentrations may exist at briefly lit lunar polar locations outside persistently shadowed regions. A lunar rover could be remotely operated at some of these locations for the 4-7 days of expected sunlight at relatively low cost.

Given the relatively short time period this lunar mission is being designed to, prospecting for sites of interest needs to occur near real-time. The two instruments which are being used for prospecting are the neutron and NIR spectrometers (Fig. 1). A neutron spectrometer will be used to sense hydrogen down to concentrations as low as 0.5WT% to a depth of approximately 80 cm. This instrument is the principle instrument for identifying buried volatiles. A NIR spectrometer, which includes its own light source, will look at surface reflectance for signatures of bound H2O/OH and general mineralogy. Once an area of interest is identified by the neutron and/or NIR spectrometer (what was referred to as a "hot spot") the option to drill is considered. The drill can either auger or core. The auger drill can excavate samples to a depth of 50 cm and is monitored with a drill camera, the NIR spectrometer and thermal radiometer. If a particular location is considered of high-interest then the decision to core could be made. The coring drill (a push-tube) allows a 1-meter sample to be acquired and then processed by the OVEN/LAVA system.

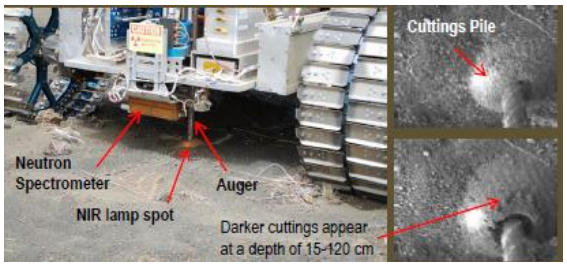

Figure 1. The RESOLVE Payload on the Artemis Jr. rover: Shown is an augering activity with the NIR lamp illuminating the drill spot the view from the Drill Camera.

RESOLVE Field Test: In July 2012 the RESOLVE project conducted a full-scale field demonstration. In particular, the ability to perform the real-time measurement analysis necessary to search for volatiles and the ability to combine the various measurement techniques to meet the mission measurement and science goals. With help from the Pacific International Space Center for Exploration Systems (PISCES), a lunar rover prototype (provided by the Canadian Space Agency) was equipped with a suite of prospecting instruments (neutron spectrometer and near-infrared spectrometer), subsurface access and sampling tools, including both an auger and coring drill (provided by CSA) and subsurface sample analysis instrumentation, including a sample oven system, the Oxygen and Volatile Extraction Node (OVEN), and Gas Chromatograph / Mass Spectrometer system, the Lunar Advanced Volatile Analysis (LAVA) system.

This presentation will describe the Resource Prospector mission, the payload and measurements, and concept of operations. The presentation will emphasize the lunar science that will be addressed by Resource Prospector.