OVERVIEW OF NASA's RESOURCE (Resource Exploration and Science of OUR Cosmic Environment) PROJECT. Jennifer L. Heldmann[1], Alexander Sehlke[1,2], A. Paz[3], J. Kleinhenz[3,4], A. Deutsch[1,5], Anthony Colaprete[1], Richard Elphic[1], Dana Hurley[6], Andy Rivkin[6], Dava Newman[7], Kris Zacny[8], Kathryn Bywaters[8], Leo Stolov[8], Josh Coyan[9], Anna Wagner[10], Darlene S. S. Lim[1], Zara Mirmalek[1,2], Alexandra Matiella Novak[6], Deena Khalil[11], and the NASA RESOURCE Team. [1]NASA Ames Research Center, [2]BAER Institute [3]NASA Johnson Space Center, [4]NASA Glenn Research Center, [5]NASA Postdoctoral Program (NPP), [6]Johns Hopkins University / Applied Physics Lab, [7]Massachusetts Institute of Technology, [8]Honeybee Robotics, [9]U.S. Geological Survey, [10]U.S. Army, Cold Regions Research Environment Laboratory (CRREL), [11]Howard University
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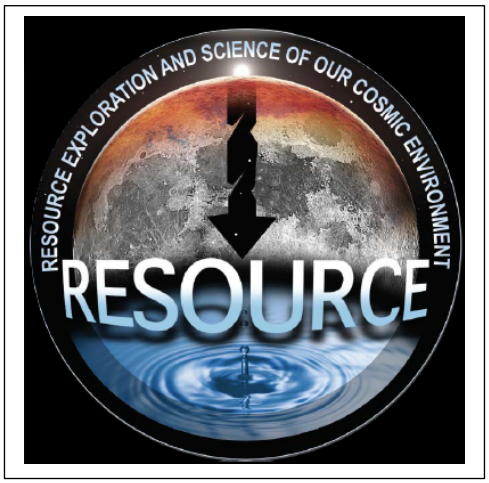
Project Overview: The RESOURCE (Resource Exploration and Science of OUR Cosmic Environment) project is supported by NASA's SSERVI (Solar System Exploration Research Virtual Institute) and is led by Principal Investigator (PI) Dr. Jennifer L. Heldmann and Deputy PI Dr. Alexander Sehlke at NASA Ames Research Center. RESOURCE is focused on enabling In Situ Resource Utilization (ISRU) near the sites of robotic and/or human missions to enable sustainable and affordable exploration of the Moon and near-Earth objects (NEOs). Below we highlight several RESOURCE activities over the past year.

Lunar Polar Crater Morphometry Analyses: Quantifying morphometric variations in lunar polar craters can provide important constraints on the distribution and abundance of polar ice. This team analyzed the elongation of small highlands craters as a function of target slope. We find that small (20–150 m) craters formed in non-level terrains often are elongated in the down-slope geometrically central point of the crater. The relatively high proportion of elongated craters identified in polar slopes thus far suggests that perhaps volatiles play a role in the final morphometries of small craters at the lunar poles (Deutsch et al. 2021).

Lunar Ice Sheet Modeling: Simulation and analysis of impact gardening effects on ice sheets in cold lunar permanently shadowed regions has been conducted. The model generates impacts stochastically using a crater size-frequency distribution (Hurley 2022). Comparing the model output to existing orbital radar and neutron data, the data are consistent with the model when assuming a 10 cm thick ice layer was emplaced 500-700 million years ago. A 10-cm thick ice layer could be produced by a 2-km comet, which is not unreasonable. Further, the model can be used for trade studies in preparation of future in-situ exploration of extremely cold permanently shadowed regions (PSRs).

Lunar Drilling Technologies: The RESOURCE team at Honeybee Robotics focused on developing a new drilling system called REBELS (Rapidly Excavated Borehole for Exploring Lunar Subsurface). REBELS is a 10+ meter drilling system for lunar prospecting and subsurface science. This is a step forward from the 1-meter class TRIDENT drill, as REBELS can drill below regolith reworked by impact gardening and access ice deposits that may be below the lunar surface.



Low-cost Technology Adaptation for Lunar Flight: The RESOURCE teams at NASA Ames and Massachusetts Institute of Technology (MIT) have developed a concept of operations and flight qualified a low-cost commercial off-the-shelf (COTS) LiDAR and RGB camera for lunar surface exploration through Virtual Reality (VR). The camera will be flown on the Nova-C lander as part of the Intuitive Machines mission IM-2 and will land at the lunar south pole.

ISRU Water Processing Plant: The RESOURCE team at NASA's Johnson Space Center (JSC) is working to process extracted water in an ISRU plant and demonstrate an integrated test of the critical components needed to capture, clean, deionize, and electrolyze water as well as dry the oxygen and hydrogen gas products. The team focuses on proton exchange membranes (PEM) and solid oxide electrolysis (SOE) techniques for water electrolysis. To compare PEM and SOE, the JSC team used a detailed ISRU system model that included water purification and gas drying steps. Based on the results of this study, RESOURCE will utilize solid oxide electrolysis as the means to split water.

Water Distribtuion Prediction Model: The RESOURCE team at the USGS's Geology, Minerals, Energy, and Geophysics Science Center conducted mineral prospectivity modeling and geostatistical activities in the last year, with a focus on predicting water distribution in the Mojave Desert as an analog dataset for predicting water on other planets. We used trend analysis and kriging to generate spatial predictions of water distribution with applications to lunar scenarios.