NIR SPECTROSCOPY AND MULTI-WAVELENGTH IMAGING FOR VOLATILE PROSPECTING.

A. M. Cook[1,2], A. Colaprete[1], T. L. Roush[1], J. E. Benton[1,3], J. B. Forgione[1], B. White[1], R. Bielawski[1], E. Fritzler[1,2]. [1]NASA Ames Research Center, M/S 245-6, Moffett Field, CA 94035, [2]Millennium Engineering and Integration, M/S 213, Moffett Field, CA 94035, [3]Wyle Engineering, Moffett Field, CA 94035.

Introduction: We present a demonstration of an instrument system built at NASA Ames Research Center, for in situ near-infrared spectral observations and visible imagery of planetary surfaces. The Near-InfraRed Volatile Spectrometer System (NIRVSS)[1] is comprised of two main structural components, pictured in Figure 1: the spectrometer box, which houses two NIR spectrometers, and the "bracket assembly" which includes a camera, 8 LEDs, optical fiber mounts for the spectrometers, a near-infrared source lamp, and 4 radiometers for long-wave infrared characterization. The primary science goal of NIRVSS is to detect and characterize the abundance of H_2O/OH and other volatiles on planetary surfaces.

Resource Prospector Mission: The current instrument design is driven primarily by requirements of the Resource Prospector rover mission to the lunar poles in ~2022. For this mission, NIRVSS serves as a prospecting instrument, mounted to the underside of the rover, viewing the ground as the rover traverses. The two spectrometers span adjacent wavelength ranges (1.59 - 2.39 and 2.31- 3.39 microns) that target the detection of OH bands indicative of water and other volatiles on the lunar surface. The near-IR tungsten filament lamp on the bracket projects a beam onto the ground beneath the rover, which reflects back up in to the viewports for the spectrometer fibers. The four radiometers (8, 10, 12.5, and 25 microns) provide calibration for higher temperature surfaces that can contribute thermal radiance within the range of the spectrometers. They can also characterize surface temepratures between approximately 80 to 400K.. Finally, the newly-updated Drill Observation Camera (DOC) is accompanied by 8 LED illumination sources with the following peak wavelengths: 410, 540, 640, 740, 905, 940, 1050, and a white broadband LED.

All components of NIRVSS are meant for use during both rover prospecting and drilling operations over specific targets of interest. The system could provide the mission's first measurements of increased OH-signatures, as subsurface soils are delivered to the surface by the RP drill.

Other Missions and Field Applications: The NIRVSS instrument provides a capability that is relevant beyond the moon. Remote observations of Mercury [2], Ceres [3], Phobos [4], and other airless bodies indicate the likely presence of water and other volatiles. The NIRVSS instrument is an ideal in situ in-

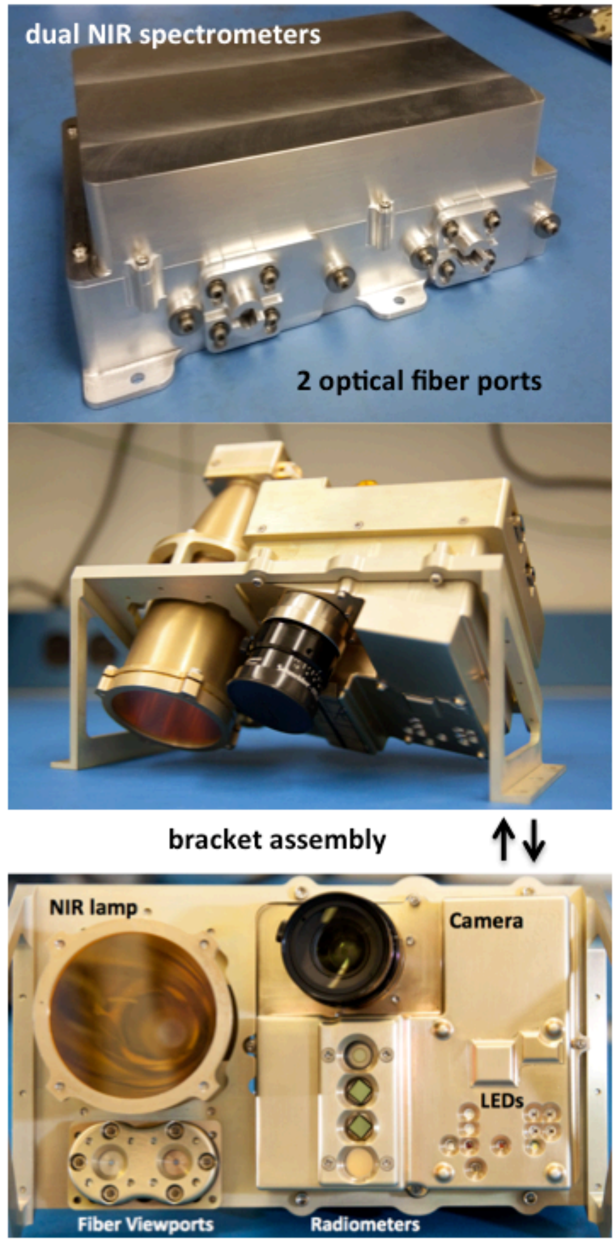

Figure 1. The NIRVSS instrument. Top panel: the dual spectrometer housing, with fiber ports. Middle Panel: a side view of the bracket assembly, pointing diagonally downward as it will from the Resource Prospector rover. Bottom Panel: Front view of the bracket assembly, annotating the location of various components discussed in the text.

strument to characterize the distribution of hydrated and/or hydroxylated deposits on these bodies.

In addition, the InField instrument is a version of NIRVSS that is being modified to study its potential use during human exploration missions. For InField, the same capabilities are being packaged into a < 35-lb backpack, with supporting equipment (batteries, harnessing, laptop, etc.) for field testing in collaboration with the BASALT (Biologic Analog Science Associated with Lava Terrains) team expeditions [5]. This iteration of the instrument provides adjustable fields of view for the spectrometers, by integrating a set of lenses to the bracket assembly in front of the fiber viewports. Smaller fields of view provide an opportunity to examine the spectral signal from much smaller features, some of which may contain biomarkers.

The range of wavelengths included in the camera's accompanying LEDs allow the NIRVSS system to capture images at individual wavelengths. The resulting images at each wavelength allow fluourescing features and OH-bearing mineral inclusions to be highlighted in contrast to surrounding material. The images are a highly informative complement to the spectral data.

Laboratory & Field Demonstrations:

We will present data from engineering tests in Glenn Research Center's VF13 vacuum chamber, where NIRVSS observed the Honeybee Robotics Resource Prospector drill deliver cuttings of a cryogenically cooled, water doped lunar simulant from depth into the NIRVSS field of view. Spectral data and images from this test demonstrate the ability of the NIRVSS system to sense water in real time, as it's being delivered to the surface.

We will also present data from initial testing of InField, which is slated for its first in-simulation field test in Hawaii Volcanoes National Park in November 2016.

References: [1] Roush, T. L. et al. (2016) *AIAA SCiTech Forum 2016*, Doc. ID: 20160000304. [2] Neumann, G. A. et al. (2013) *Science*, 339, 296-300. [3] Küppers, M. et al. (2014) *Nature*, 505, 525-527. [4] Fraeman et al. (2014), *Icarus*, 229, 196-205 [5] Lim, D. S. S. et al. (2015) AGU Fall Meeting 2015, #P31A-2031.