MULTICOLOR IMAGERY AND NIR SPECTROSCOPY INSTRUMENTATION FOR PLANETARY SURFACE VOLATILE PROSPECTING. A. M. Cook1,2, A. Colaprete1, T. L. Roush1, S. J. Thompson3, J. E. Benton1,4, J. B. Forgione1, R. Bielawski1, E. Fritzler1,2, R. McMurray,1 NASA Ames Research Center, M/S 245-6, Moffett Field, CA 94035, 2Millennium Engineering and Integration, M/S 213, Moffett Field, CA 94035, 3Intrinsyx Technologies Corporation, Moffett Field, CA 94035, 4Wyle 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) is comprised of two main structural components, pictured in Figure 1: the spectrometer box containing two NIR spectrometers, and the “bracket” which includes a camera, 8 LEDs, optical fiber mounts for the spectrometers, a near-infrared source lamp, and 4 radiometers for long-wave infrared calibration purposes. The primary science goal of NIRVSS is to detect and characterize the abundance of OH and other volatiles on planetary surfaces.

Resource Prospector Mission: The current instrument design is driven primarily by requirements of the Resource Prospector [1] rover mission to the lunar poles in ~2021. 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 source on the bracket projects a beam onto the ground beneath the rover, which is scattered and reflected back into the optical inputs for the spectrometer fibers. The four radiometers (8, 10, 12.5, and 25 microns) are to characterize surface temperatures, enabling a correction for thermal emission contributions potentially measured by the spectrometers. Finally, the newly-updated Drill Observation Camera (DOC) is outfitted with 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 operations, and during drilling operations over specific targets of interest. The system would 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 capabilities that are useful beyond the Resource Prospector mission. A version of the instrument was used for a science-driven field campaign in the Mojave desert in 2014 [2], to search for signs of hydration in the arid landscape at the base of a cinder cone near Zzyzx. NIRVSS is slated for use in 2016 field tests at Craters of the Moon National Park in Idaho and at Mauna Kea, Hawaii. Other potential field campaigns related to life detection also await funding.

Likewise, missions to other planetary bodies would benefit from the use of the NIRVSS instrument, to identify water and other volatile materials in planetary soils, whether through spectroscopy, imaging, or a combination of both.

Laboratory Demonstration: Here we present new laboratory data from the latest iteration of the NIRVSS system, using relevant soil samples and pure mineral samples to demonstrate the unique ability of NIRVSS to identify volatiles (particularly OH-bearing species) using spectroscopic data and multiwavelength imagery. Figure 2 shows an example of mineralogical features in rock samples from a recent field test; rock inclusions are distinguishable by the DOC imaging system using the bank of multiwavelength LEDs on the bracket. These images can be correlated with spectral data from the same scene to confirm the presence of certain minerals as seen in 1.5 to 3.4-micron absorption bands.

Figure 1. The NIRVSS Instrument, after Roush et al. [3] Top panel and bottom right panel: bracket assembly with IR emitter cone, Drill Observation Camera (DOC), LEDs, radiometers, and fiber optic viewing ports. Bottom left panel: spectrometer housing showing two optical engines.
References:


Figure 2. Example images from the Drill Observation Camera (DOC), demonstrating the ability of the NIRVSS system to distinguish small-scale mineralogical variation in sample rocks. The left image is a 3-color composite, while the right image is the result of differencing images taken using different LED light sources.