RELAB (REFLECTANCE EXPERIMENT LABORATORY): A NASA MULTIUSER SPECTROSCOPY FACILITY. Carlé M. Pieters[1] and Takahiro Hiroi[1], [1]Deptartment Geological Sciences, Brown University, Providence, RI 02912, (Carle_Pieters@brown.edu; Takahiro_Hiroi@brown.edu)

Overview: Spectroscopic analysis of planetary surfaces is a central component of remote sensing in solar system exploration. A host of sensors, of increasing sophistication, are includeed on both orbital and in-situ platforms. The wavelength range of useful data extends from the visible through the mid-infrared. The RELAB (Reflectance Experiment Laboratory) facility at Brown University provides a mechanism for researchers to obtain high quality laboratory spectra of geologic materials for use in compositional and/or geologic applications. NASA supports the RELAB as a multiuser spectroscopy facility and laboratory time can be made available at no charge to investigators funded by NASA programs. A multiuser open facility is the most cost-effective way to meet the needs of the science community and data analysis objectives. Information on this facility, a *RELAB User's Manual,* sample submittal forms, and access to the wide variety of RELAB spectroscopy data in the public domain available for scientific use can be found at:

http://www.planetary.brown.edu/relab/

The facility. The RELAB has continually evolved to produce data of high quality and to maintain up-to-date components. Currently there are two principal spectrometers, which work in tandem but samples can be measured in both without changing sample preparation: 1) a bi-directional reflectance spectrometer for visible to near-infrared wavelengths, and 2) a Nicolet 870 Nexus FTIR spectrometer for a) near- to far-infrared diffuse reflectance measurements using a Pike multi-sample holder, or b) near- to mid-infrared microspectroscopy measurements using a Continu m microscope.

The bi-directional reflectance spectrometer, operates from 0.3 to 2.6 m. The basic geometry of this system is shown in Figures 1 and 2. It is specifically designed to mimic the geometry of remotely acquired data, where the incident light (sun) is provided by a monochromater and can be set to any angle on the sample surface. Similarly, the detector platform can be rotated to any angle in order to mimic the viewing geometry of the sensor (in the same scattering plane).

The RELAB bidirectional spectrometer is optimized to obtain visible to near-infrared spectra at high precision (1/4%) for most forms of particulate materials including small valuable samples (*e.g.*, meteorites and lunar samples). Rock samples or chips can be accommodated with a different platform. Spectral sampling interval is chosen by the user (typically 5 — 10 nm). Spot size as small as ~1 mm are possible. Most particulate samples are 100-500 mg, but samples as small as 5-10 mg have been successfully measured. This bidirectional nature is ideally suited for remote sensing applications.

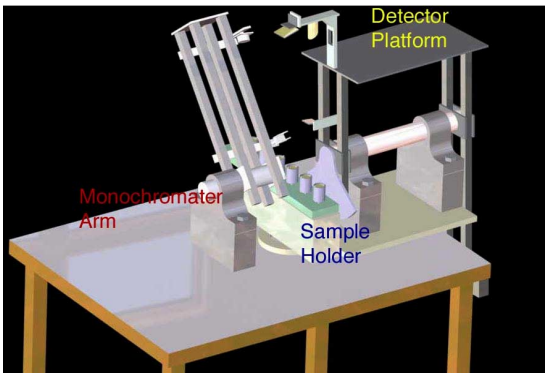

Figure 1. Schematic diagram of the RELAB bi-directional spectrometer. The monochromater light source and detectors are not shown.

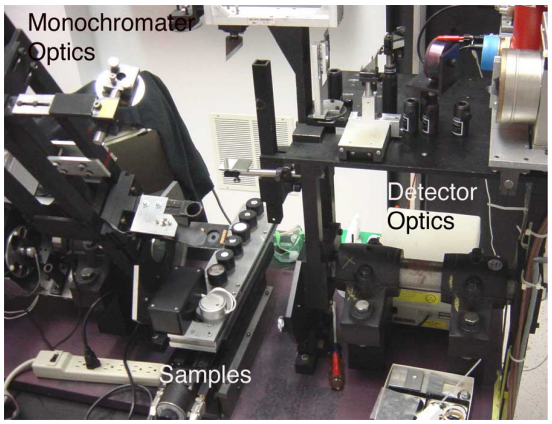

Figure 2. Central components of the RELAB bi-directional spectrometer. This sample holder consists of up to 5 samples and a reference standard. A separate, height-adjustable sample platform is used for larger rock chips.

The second instrument uses a Nicolet 870 Nexus FTIR spectrometer for near- to far-infrared measurements. Components of the system are shown in Figure 3. Much of this system was purchased through private donations to Brown University, but the system is maintained under the NASA RELAB facility and is hence available to RELAB users. Currently, the system consists of three components: a) the Nicolet 870 Nexus interferometer, b) the Pike diffuse reflectance accessory, and c) the Continu m microscope. The Nicolet 870 Nexus is a stable system that is fully compliant with modern calibration requirements. Its base unit allows transmittance measurements of solid, liquid, or gas samples. The Pike diffuse accessory allows off-axis biconical measurements of multiple samples under

a purged environment. This geometry is particularly advantageous because it almost eliminates any specular component of reflectance (necessary to mimic features observed in emittance data). The Pike system is now operational from 1—50 m (100 m for some samples). [Current examples can be found in the Pieters et al abstract on Mars Spectroscopy Consortium, these abstracts.] The Continu m microscope is well suited for transmission data and is currently under testing for reflectance data [for examples see abstract by Klima and Pieters these volumes]. Due to the nature of light interation with geologic materials (volume vs surface scattering), it is best suited for high spatial resolution reflectance measurements in the near- to far-infrared where surface scattering is dominant. The Continu m system is designed to obtain precision raster scans of spectra producing an image cube of data.

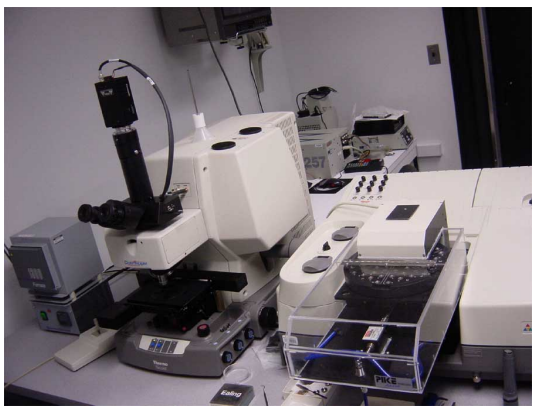

Figure 3. The RELAB Nicolet Nexus 870 FTIR system. Shown on the right is the Pike multisample diffuse reflectance accessory surrounded by the Nexus spectrometer. The Continu m microscope is attached to the spectrometer on the left.

Access to the facility. Any research scientist in a NASA program has access to the RELAB facility without charge. [In times of heavy use, however, the sample queue may be long.] A 5-person RELAB outside advisory committee advises RELAB personnel on priorities. For example, users in a funded program have priority over those who are running exploratory tests. Large groups of samples are run in background mode. Spectral measurements do not normally require the presence of the user unless there are special preparation requirements. Most RELAB users prepare their samples in the form they want measured and send them to the RELAB through the mail. Any special requirements, however do need to be undertaken by the user and would require the presence of the user.

Submittal procedures typically include:

- Contact RELAB personnel (Pieters or Hiroi) to indicate you intend to submit samples and the general nature of the samples.
- Read the sample preparation requirements in the *Users Manual* or ask RELAB personnel for advice.
- Fill out the required submittal forms available on the RELAB website: User Registration Form, Sample Information Form (describes each sample), Measurement Request Form (specifies the measurement options and priority of the data), and Compositional Analysis Form (when available).
- Send the samples and the RELAB forms to the RELAB Manager (Hiroi). The forms can be submitted electronically.

When the data have been acquired, the data are sent to the user and the samples are returned. After a user-specified period of time (typically up to 3 years) the data are included in the public domain and also available through the RELAB data base.

Upgrades. Current planned upgrades to the RELAB facility include a) replacement of the monochromater and modernization of the data acquisition system, b) redesign of the bidirectional spectrometer bench to allow out-of-plane measurements. These are likely to begin during the summer of 2004. When complete, they will allow an environment chamber to be designed for the visible to near-infrared bidirectional data. The monochromater system is ideally suited for this because very little energy is incident on the sample allowing accurate temperature control.

Inquiries: Visitors are welcome. A small office is available for users who chose to visit. Information about the RELAB including details about measurement capabilities and options can be found at:

http://www.planetary.brown.edu/relab/

Direct any specific queries to:

Dr. Carle M. Pieters
RELAB Science Manager
Department of Geological Sciences
Box 1846,
Brown University
Providence, RI 02912-1846
Telephone: (401) 863-2417
Carle_Pieters@brown.edu

or

Dr. Takahiro Hiroi
RELAB Operations Manager
Department of Geological Sciences
Box 1846,
Brown University
Providence, RI 02912-1846
Telephone: (401) 863-3776
Takahiro_Hiroi@brown.edu