SPECTROSCOPY AND GEOCHEMISTRY FACILITIES AT THE STONY BROOK UNIVERSITY CENTER FOR PLANETARY EXPLORATION. T. D. Glotch[1], A. D. Rogers[1], and J. A. Hurowitz[1]
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Introduction: The Stony Brook University Center for Planetary Exploration (CPEx) will move into a new state-of-the-art 6500 ft^2 facility in May, 2016. Within CPEx are the Vibrational Spectroscopy Laboratory (VSL), directed by Timothy Glotch, the Earth and Planetary Remote Sensing Lab (EPRSL), directed by Deanne Rogers, and the Planetary Geochemistry Laboratory (PGL), directed by Joel Hurowitz. Together, these labs within CPEx provide the core of analytical and data processing and analysis facilities used in the planetary sciences at Stony Brook. These facilities are available to the planetary science community on a user fee basis. Future facility support by NASA or NSF would reduce or eliminate user fees. Below, we describe the spectroscopic and geochemical facilities available at Stony Brook.

Sample Preparation: The Stony Brook University (SBU) Department of Geosciences has all of the equipment necessary to process solid samples in preparation for analysis. These facilities include water-cooled rock saws for cutting rock tablets, or "blanks" for preparation of polished thin sections and/or XRF analysis of major, minor, and trace elements. We also have a hardened-steel jaw crusher and hardened-steel mortar and pestles for pulverizing rock samples to mm-sized fragments that can be fed into either a SPEX Shatterbox or Retch planetary ball mill for production of finely comminuted sample powders. Both the Shatterbox and ball mill are fitted with agate grinding containers, which minimize trace element contamination of samples. Fine-grained powders can be directly analyzed by a variety of spectroscopic techniques subject to sample digestion procedures at SBU for elemental analysis. Sample digestion facilities at SBU include graphite crucibles and muffle furnaces that can achieve temperatures required for flux-assisted (lithium metaborate, lithium tetraborate) sample fusion (1100°C). Teflon beakers, stir bars, and stir plates for acid dissolution of molten flux beads are also available. Finally, we have large volume low temperature ovens and heat lamps for drying unconsolidated sediment samples, brass sieves, a sieve shaker, and a sonic sievier for grain size separation analysis of samples, a Franz magnetic separator for separation of magnetic components (if deemed necessary), and all of the equipment needed for segregating and glycolating the <2μm size-fraction for clay mineral analysis, including sonicators, vacuum filtration flasks and filters, centrifuges, and low-temperature ovens. Additional sample preparation equipment includes a Carver hydralulic press for KBr pellet preparation, a Buehler HandiMet2 roll grinder for sample polishing, a Lapcraft L'il Trimmer rock saw and a Fisher B200 ulstrasonic cleaner.

Planetary Geochemistry Lab:

X-ray Fluorescence: The Department of Geosciences has a state-of-the-art Bruker S4 Pioneer wavelength dispersive X-ray fluorescence (WDXRF) spectrometer. The X-rays are generated in the WDXRF instrument using an X-ray tube with a rhodium anode that is powered by an integrated 2.7kW high voltage power supply. Fluorescent X-rays are collimated and directed onto a set of analyzer crystals to sequentially isolate the element X-ray emission line of interest for analysis on a proportional counter (light elements) or a scintillation detector (heavy elements). The instrument can be used for the elemental analysis of solid samples at the atomic mass of beryllium through uranium in concentration ranges from sub-ppm to weight %.

ICP-OES: A Thermo iCAP 6300 Radial View Inductively-Coupled Plasma Optical Emission Spectrometer (ICP-OES) can be used for the analysis of fluid samples collected in the field or produced during experimentation. The ICP-OES is capable of measuring the total elemental concentrations of major, minor, and a large number of trace elements to ppb levels, and is equipped with a Cetac ASX-260 auto-sampler which allows for the automated analysis of up to 48 samples in a single session.

Vibrational Spectroscopy Laboratory:

Mid-IR Emissivity: VSL houses two Thermo Fisher Nicolet 6700 Fourier Transform Infrared (FTIR) spectrometers modified to also collect emissivity spectra in an environment purged of water vapor and CO_2. Emissivity measurements can be acquired from 4000-50 cm^{-1} using a set of interchangeable detectors and beamsplitters. Measurements are calibrated to emissivity using a custom-built high emissivity blackbody target. A piezoelectric cooler is available for emissivity measurments at temperatures of -20 °C.

Attached to one FTIR spectrometer is the Planetary and Asteroid Regolith Spectroscopy Environmental Chamber (PARSEC), a custom-built planetary environmental spectroscopy chamber. This chamber is capable of achieving a vacuum of better than 10^{-5} mbar, and includes an LN2 cooled radiation shield, a six-sample rotating stage with heated sample cups, a solar illumination lamp, and internal optics to allow for mid-IR emissivity (2000-400 cm^{-1}) and VNIR biconical

reflectance (350-2500 nm) measurements in a simulated lunar or asteroid environment. The chamber will soon include a gas handling system and %RH meter to allow for non-vacuum environmental (Mars) conditions.

Mid-IR Reflectance and Microscopy: Both FTIR spectrometers can be equipped with a SmartOrbit attenuated total reflectance (ATR) accessory with a Type IIa diamond element for ATR analyses or a FT-30 accessory for specular reflectance measurements. In addition, the spectrometer can be equipped with a Pike InetegratIR gold-coated integrating sphere for hemispherical reflectance measurements from 500-4000 cm^{-1} (2.5-20 µm).

VSL also houses a Nicolet iN10MX FTIR microscope equipped with a liquid nitrogen cooled MCT 16 pixel linear array detector capable of acquiring hyperspectral image cubes between 7000 and 715 cm^{-1}. Pixel sizes are 25 or 6 µm for reflectance and transmission modes and 25 or 1.3 microns for ATR (Ge crystal) mode. Hyperspectral image cubes can be saved in ENVI format for easy processing. The iN10MX is also equipped with a DTGS detector capable of acquiring 50 x 50 micron point spectra between 4000 and 400 cm^{-1}.

Visible-to-Near-IR Reflectance: Additional major equipment in VSL includes an ASD Fieldspec3 Max UV-VIS-NIR spectrometer, which operates from 0.35-2.5 µm. This instrument is available for laboratory bidirectional reflectance measurements with adjustable incidence and emergence angles. This instrument can be equipped with an 8 degree or 1 degree foreoptic lens or a high intensity contact probe, enabling high quality analyses of small and/or dark samples. Samples measured by the ASD spectrometer can be heated to 350 °C or cooled to -196 °C under rough (~10^{-3} mbar) vacuum conditions using a Linkam THMS350V vacuum heating/cooling stage fitted with quartz windows.

Confocal Raman Microscopy: Additional spectroscopic equipment in VSL includes a WiTEC alpha300R confocal Raman microscope system equipped with a frequency doubled 532 nm Nd:YAG excitation laser and a 785 nm diode excitation laser. This Raman imaging spectrometer acquires spectra from 3500-100 Δcm^{-1} and is equipped with multiple objective lenses, ranging from 4X to 100X magnification, enabling spatial resolutions between several microns and 350 nm/pixel. The microscope also includes an ultra-long working distance objective to enable measurement of high-pressure materials in diamond anvil cells. This confocal Raman system utilizes two optimized UHTS 300 f/4, 300 mm focal length imaging spectrometers. Each spectrometer has a motorized double grating turrets equipped with a 600 and 1800 groove/mm grating (for the 532 nm laser) or 600 and 1200 groove/mm grating (for the 785 nm laser), enabling spectral resolution of ~3 and ~1.3 cm^{-1} respectively.

Earth and Planetary Remote Sensing Lab:

Field Equipment: A FLIR Systems T640 handheld infrared camera is available for field and/or laboratory studies. The camera senses broadband radiance between ~7.5-13 micrometers, and has an absolute temperature accuracy of 2K at ambient temperature. Relative temperature accuracy between pixels is about 0.1K. The field of view is 25°x18° across a 640x480 pixel array, giving the camera a pixel IFOV of 0.7 mrad. The lab also houses a Decagon EC-5 soil moisture sensor with 5 cm probe length.

Computing Resources: The EPRSL houses 6 fast Dell Precision Workstations, running under Red Hat Enterprise Linux (5) or Windows (1) with over 6 TB storage space for users. Research software includes ENVI, ArcGIS, Matlab, Davinci, JMars and JEarth, Craterstats, ISIS, CRISM Analysis Toolkit, Ames Stereo Pipeline photogrammetry functions, and FLIR ExaminIR. A small number of data sets are stored in EPSRL, most of which cover Long Island, NY. These include Landsat reflectance, NDVI, and temperature records from 1980-2010, USGS soil maps, and a 30 m/pixel DEM generated from USGS topo quads.

Conclusions:

The Stony Brook Center for Planetary Exploration and its constituent labs offer a range of geochemical and spectroscopic characterization capabilities and data analysis facilities of interest to the planetary science community. Potential users should contact Joel Hurowitz (joel.hurowitz@stonybrook.edu) for informtation regarding geochemical characterization of samples and Timothy Glotch (timothy.glotch@stonybrook.edu) or Deanne Rogers (Deanne.rogers@stonybrook.edu) for information regarding infrared or Raman spectroscopic characterization.