Mercury and the Moon: Initial findings from mid-infrared spectroscopic measurements of the surface. K. L. Donaldson Hanna[1], A. L. Sprague[1], R. W. H. Kozlowski[2], K. Boccafolo[2], and J. Warell[3], [1]Lunar and Planetary Laboratory, University of Arizona, 1629 University Blvd., Tucson, AZ, 85721, khanna@lpl.arizona.edu, sprague@lpl.arizona.edu, [2]Susquehanna University, Selinsgrove, PA 17870, kozlowsk@susqu.edu, and [3]Uppsala University, Box 515, S-751 20 Uppsala, Sweden, Johan.Warell@astro.uu.se.

Introduction: Mid-infrared spectroscopic measurements from 8.2 – 12.7 µm of Mercury and the Moon were made at the NASA Infrared Telescope Facility (IRTF) using Boston University's Mid-InfraRed Spectrometer and Imager (MIRSI). Spectral images of Mercury were acquired at West longitudes 172 - 282° covering north to south polar latitudes. These measurements included Caloris Basin, Basin S [1], and other surface features not imaged by Mariner 10. Spectral measurements of the lunar surface were acquired for the Apollo 16 landing site, the Grimaldi basin and surrounding highlands, and Copernicus crater. Locations on the lunar surface were chosen for their known surface compositions determined from near-infrared spectral telescopic observations and Apollo return samples.

Laboratory reflectance spectra from the ASTER spectral library [2] and true emission spectra from the Planetary Emissivity Laboratory [3], were analyzed for comparison with our reduced spectral measurements. Comparisons of our Grimaldi mare and highlands spectral measurements with ASTER laboratory spectra will permit diagnostic surface chemistry of locations on the lunar surface where there were no return samples. Spectral modeling is necessary and underway for both Mercury and the Moon.

Observations: Mid-infrared spectral measurements of Mercury and the Moon were obtained at the IRTF from 7 – 16 April 2006, using the MIRSI instrument. Daytime observations of Mercury were made as it transited at 19:00 GMT and nighttime observations were made of the Moon as it transited at 10:00 GMT. MIRSI contains two grisms, a 10 micron grism covering the 8.2 – 12.7 µm spectral region at a resolution of 200 and a 20 micron grism covering the 17 – 26 µm spectral region at a resolution of 100 [4]. Our spectral measurements only used the 10 micron grism. The MIRSI instrument has a large field of view (85" x 64") with a slit size of 0.6" [4]. The MIRSI slit is easily positioned over the illuminated disk of Mercury (Fig. 1) and the Moon (Fig. 2) using the filter image mode of the system just prior to spectral measurements being taken. Spectral measurements of the Moon were made using the same strategy as with the Mercury observations.

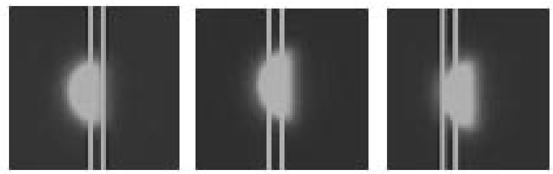

Fig. 1. A series of 7.7 µm filter images of Mercury taken just prior to our spectral images. The white rectangles represent the approximate slit location during our spectral observations of the terminator, center of Mercury's illuminated disk and the limb. These Mercury filter images were collected on 7 April 2006 when Mercury had a diameter of 7.9" and was 46% illuminated.

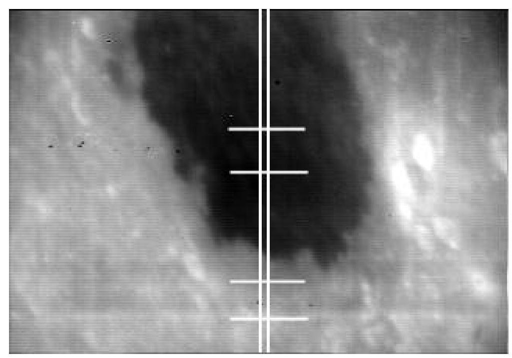

Fig. 2. A 2.2 µm filter image of Grimaldi basin taken just prior to our spectral images. The white rectangle represents the approximate slit location during our spectral observations. The white horizontal lines indicate the spectral regions extracted. This lunar filter image was collected on 16 April 2006.

Results: Reduced spectral measurements from five different locations on Mercury's surface corroborate a heterogeneous surface composition (Fig. 3 top). Local EM and TM are at distinctly different wavelengths in each spectrum. In the spectrum centered on Caloris Basin (200 - 210° W) a local EM centered at 10.5 µm is not seen in any of the other spectral measurements and the overall shape of the Caloris Basin spectrum is unlike the other spectra.

Spectra from longitudes centered on Caloris Basin and just west of Caloris Basin (225 - 235° W) were compared with laboratory spectra and the Sprague and Roush model spectrum [5] (Fig. 3 bottom). Our spectra exhibit a similar Na-rich feldspar feature centered at 11.5 μm as the Sprague and Roush model spectrum [5]. The Caloris Basin spectrum also has a local EM centered at 8.4 μm characteristic of enstatite and a TM at 12.5 μm indicative of a 40 – 46 wt. % SiO_2. Just west of Caloris Basin a TM at 12.6 μm indicates an ultra-mafic composition (34 – 40 wt. % SiO_2) and is the most mafic spectral measurement that we have taken to date. Cooper et. al also measured a similar transparency minima at 12.6 μm centered on a longitude of 229° W [6]. A different transmission filter may permit measurements of other EM at wavelengths shorter than 8.2 μm. More modeling is necessary for inferring composition.

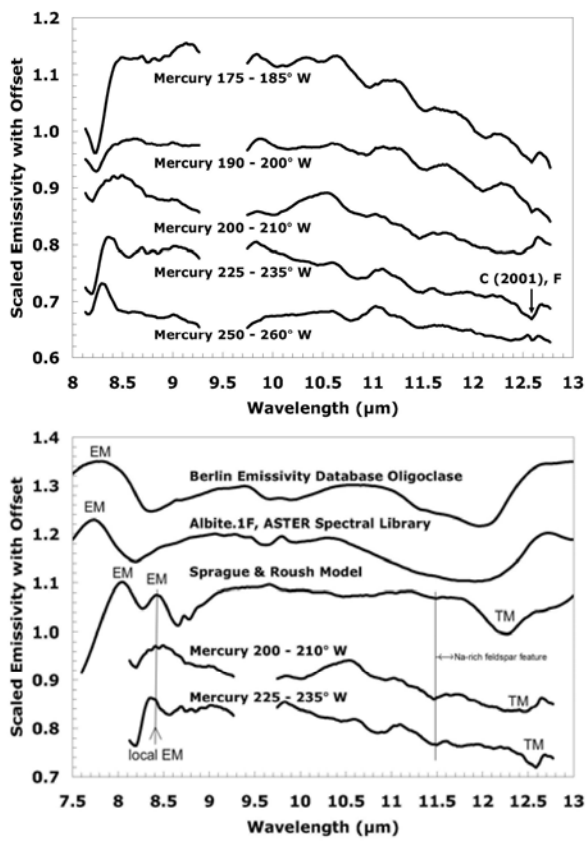

Figure 3. **(Top)** Reduced spectra from five locations on Mercury's illuminated disk. **(Bottom)** Two reduced Mercury spectra are plotted along with two laboratory spectra and a model spectrum produced by Sprague and Roush [5]. Oligoclase spectrum is from the Berlin Emissivity Database (true emission, grain size of 0 - 63 micrometers [3]). Albite.1F is from the ASTER Spectral Library (directional hemispherical reflectance spectrum, grain size of 0 - 75 micrometers [2]).

Spectra from the Grimaldi mare and highlands are similar except for a characteristic difference at 10.3 μm. The mare spectrum has a broad local maximum, but the highlands spectrum has a broad local minimum at the same wavelength region. Both spectra are unlike those obtained from Mercury.

Grimaldi basin measurements were compared with ASTER laboratory reflectance spectra of fine-grained Norite (Norite.H2), an Apollo 12 maria soil sample (12030.135) and an Apollo 16 highlands soil sample (61221.79) [2]. Similarities are seen between the Grimaldi mare and highlands spectra and the Norite.H2 spectrum from 11 – 13 μm, in particular the location and shape of the TM. Three local minima in the Grimaldi spectra (denoted by arrows in Figure 4) are also seen in the Apollo 12 and 16 sample return spectra. These similarities permit us to make surface chemistry identifications for regions on the lunar surface where no return samples were taken.

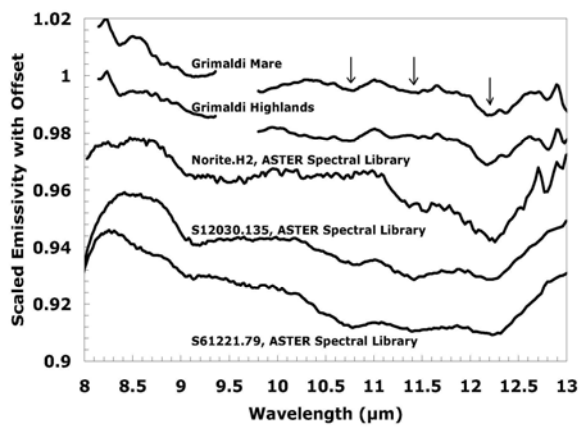

Figure 4. Three laboratory spectra are plotted along with two observed lunar spectra on the same wavelength scale. All laboratory spectra are directional hemispherical reflectance spectra with grain sizes of 0 - 75 micrometers [2].

References: [1] Ksanfomality L. V. and Sprague A. L. (2007) *Icarus, in press*. [2] ASTER Spectral Library, JPL, http://speclib.jpl.nasa.gov. [3] Helbert J. et al. (2006) *Adv. Space Res., in press*. [4] Deutsch L. K. et al. (2002) *SPIE, 4841*, 106-116. [5] Sprague A. L. and Roush T. L. (1998) *Icarus, 133*, 174-183. [6] Cooper B. et al. (2001) *JGR, 106,* 32,803-32,814.

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