HIGH-SPATIAL-RESOLUTION VISIBLE TO NEAR-INFRARED REFLECTANCE OF MERCURY'S SURFACE OBTAINED DURING THE FIRST MESSENGER FLYBY. Noam R. Izenberg[1], William E. McClintock[2], Gregory M. Holsclaw[2], David T. Blewett[1], Deborah L. Domingue[1], Kerri L. Donaldson Hanna[3], James W. Head III[4], Elizabeth A. Jensen[5], Mark C. Kochte[1], Mark R. Lankton[2], Scott L. Murchie[1], Mark S. Robinson[6], Sean C. Solomon[7], Ann L. Sprague[3], Faith Vilas[8], and the MESSENGER Team. [1]JHU/APL, Laurel, MD 20723 (noam.izenberg@jhuapl.edu); [2]LASP, U. Colo., Boulder, CO 80303; [3]LPL, Univ. of Ariz., Tucson, AZ 85721; [4]Brown U., Providence, RI 02912; [5]ACS Consulting, Houston, TX 77001; [6]ASU, SASE, Tempe, AZ 85287; [7]DTM, Carnegie Inst. of Washington, Washington, DC 20015; [8]MMT Observatory, Tucson, AZ 85721.

Introduction: On January 14, 2008, the MESSENGER spacecraft will fly by Mercury for the first time, as part of its long journey to Mercury orbit insertion. The Mercury Atmospheric and Surface Composition Spectrometer (MASCS) [1] will conduct exosphere and surface observations during the flyby, including the first high-spatial-and-spectral resolution visible to near-infrared (IR) spectra of the Mercury surface. The Visible and InfraRed Spectrograph (VIRS) component of MASCS covers the spectral range 320-1450 nm at 5-nm spectral resolution over two detectors (visible or VIS channel 320-950 nm; near-IR or NIR channel 900-1450 nm). Here we discuss the MASCS VIRS dataset for the first Mercury flyby and its application to the mineralogical investigation of the Mercury surface. Related abstracts in this session discuss an overview of the flyby [2], spectroscopy [3], color imaging and photometry [4, 5], spectral and color integration [6], and ultraviolet (UV) surface reflectance [7].

The MASCS Ground Track: Fig. 1 shows the ground track of the MESSENGER instrument boresight, along which MASCS is aligned, across the surface of Mercury illuminated at the time of the first Mercury flyby. VIRS will begin acquiring spectra nearly a minute before crossing the terminator and will continue accumulating 1-s exposures (with an overhead gap of 0.25 s) until about one minute after the boresight leaves the limb of the planet. Approximately 665 visible to near-IR spectra will be accumulated across the surface, near the equator from about 96° to 192° E longitude. The majority of the ground track, and about half of the data (Fig. 1), will be in regions of Mercury not imaged by Mariner 10. Arecibo radar imaging [8, 9] of the VIRS ground track area shows cratered surfaces broadly similar to the Calorian cratered plains units of Mercury's Tolstoj quadrangle [10, 11]. The ground track will cut two radar-bright areas [12, 8]; the southernmost extensions of radar feature "C" and the slightly less-radar-bright feature extending in a rough semicircle to the south of Mozart crater. The remaining ground data will cross an area southeast of Mozart crater, around the border between the crater's blocky ejecta blanket and the surrounding Tir Planitia [10]. Spectra in this part of the flyby will likely sample intercrater plains, smooth plains, and several types of crater materials including Mozart ejecta.

The first illuminated spectra of the Mercury surface will be taken as the VIRS field of view crosses the terminator at approximately 19:13:30 UT, or ~530 s after closest approach. The spacecraft will be at or near nadir viewing at this time. The phase angle of the first Mercury spectra will be 90°, with incidence and emission angles near 90° and 0°, respectively. Due to spacecraft motion, the VIRS footprint on the surface will be significantly smeared by the 1-s integrations. With a circular instantaneous field of view of 0.023°, the first footprints will be approximately 740 m across and 3420 m long. Ground resolution will vary throughout the flyby, such that spectra with minimal smear will have along-track resolution of ~3 km. In other cases, as the spacecraft executes pointing maneuvers, smear will result in along-track spatial resolutions of tens of kilometers (Fig. 2). The Mozart/Tir segment of the ground track will grade from 2.3 × 3 km to 3.2 × 7.3 km footprints over about 320 spectra.

There will be two periods when the UltraViolet and Visible Spectrometer (UVVS) component of MASCS will be observing the surface contemporaneously with VIRS. The "UVVS 1-minute surface scan" (yellow in Figs. 1, 2) shows the period when both instruments observe the surface with UVVS in a ground observation configuration. The UVVS viewing direction is off-pointed (0.38°) from VIRS, and its surface observation footprint is larger (0.05° × 0.04°), so the UV surface observations [7] will be of the same regions but not precisely the same locations as those from VIRS. The second period with UVVS operating (purple in Figs. 1, 2) has the UV instrument in an exosphere configuration, not suited for ground data acquisition.

Mercury Mineralogy and VIRS: The surface of Mercury has a strong positive (red) spectral slope in the visible to near-IR [13], possibly a result of the intense space weathering environment at this location near the Sun [14, 15]. Mercury's spectrum (Fig. 3) is otherwise flat and relatively featureless and has been likened to lunar anorthositic materials [16, 17]. Mid-infrared spectral images [18] are consistent with an Mg-rich mineral with K-feldspar near parts of the first MESSENGER Mercury flyby ground track. A shallow absorption feature centered at 1100 nm has been found at two locations on Mercury [19] and has been interpreted to indicate the presence of high-Ca clinopyroxene.

Several analysis techniques will be pursued with VIRS spectral data. After calibration and an initial photometric correction, a number of spectral parameters will be derived for comparison across the full data set, including near-IR slope; visible and IR albedos corresponding to imager color filters [5]; and the center, depth, and width of the mafic mineral absorption band near 1000 nm. Specifically, we will attempt to distinguish between high-Ca clinopyroxenes (band between 800 and 1300 nm centered near 1100 nm), possible olivines (centered around 1000 nm with the long-wavelength wing beyond the MASCS range), the possibility of fresh Fe-bearing plagioclase (weak absorption centered at 1250 nm) indicative of immature anorthosites [16], and impact melt glasses, with broad absorption bands centered around 1150 nm. Orthopyroxenes, if seen in abundance, may be distinguished by bands centered near 900 nm [20, 21]. Given the instrument spatial resolution and varied geologic terrains the ground track will be crossing, it is likely that we will observe gradations as well as distinct varieties of spectral end members (Fig. 4).

Visible to IR spectral analyses will be significantly informed by the UV observations [7], which will help determine the degree of space weathering affecting surface materials. Applications of weathering models [22] to the visible-IR spectra models may be needed to recover the correct mineralogy.

References: [1] W. E. McClintock and M. R. Lankton (2007) *Space Sci. Rev.* 131, 481-522. [2] S. C. Solomon et al. (2008) *Lunar Planet. Sci.* 39. [3] W. E. McClintock et al. (2008) *Lunar Planet. Sci.* 39. [4] D. L. Domingue et al. (2008) *Lunar Planet. Sci.* 39. [5] M. S. Robinson et al. (2008) *Lunar Planet. Sci.* 39. [6] G. M. Holsclaw et al. (2008) *Lunar Planet. Sci.* 39. [7] F. Vilas et al. (2008) *Lunar Planet. Sci.* 39. [8] J. K. Harmon et al. (2007) *Icarus* 187, 374-405. [9] Arecibo map composite courtesy Phillip J. Stooke. [10] G. G. Schaber and J. F. McCauley (1980) USGS Map I-1199. [11] P. D. Spudis and J. E. Guest (1988), in *Mercury*, 118-164. [12] B. J. Butler et al. (1993) *JGR* 98, 15003-15023. [13] F. Vilas (1988) in *Mercury*, 59-76. [14] S. K. Noble and C. M. Pieters (2003) *Solar. Syst. Res.* 37, 31-35. [15] M. J. Cintala (1992) *JGR* 97, 947-973. [16] D. T. Blewett et al. (2002) *Meteorit. Planet. Sci.* 37, 1245-1254. [17] J. Warell and D. T. Blewett (2004) *Icarus* 168, 257-276. [18] A. L. Sprague et al. (2008) *Lunar Planet. Sci.* 39. [19] J. Warell et al. (2006) *Icarus*, 180, 2, 281-291. [20] J. B. Adams (1974) *JGR* 79, 4829-4836. [21]A. R. Hendrix and F. Vilas (2006) *Astron. J*, 1396-1404. [22] B. Hapke (2001) *JGR* 106, 10039-10073.

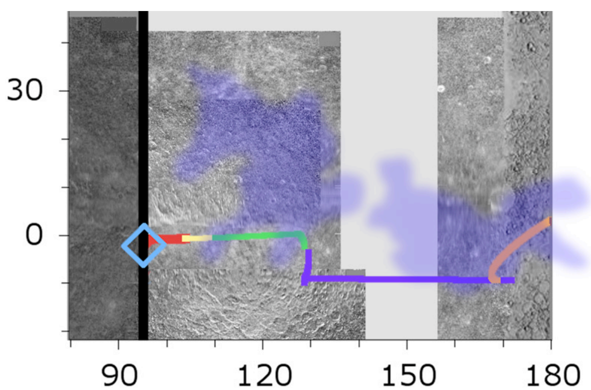

Figure 1. Close-up of Sun-illuminated portion of MESSENGER's first Mercury flyby ground track over Mariner 10 images (east of 155° E) and Arecibo radar images (west of 140° E) in cylindrical projection [8]. Diamond: Terminator crossing. Red: First surface spectra. Yellow: Combined VIRS and UVVS observations. Green: VIRS only. Purple: Rapidly changing ground track. Orange: Mozart/Tir Planitia region. Blue shapes indicate radar-bright areas "C" (left), and the near-Mozart region (right).

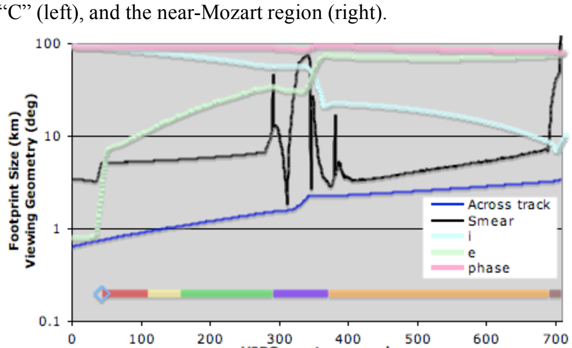

Figure 2. Footprint dimensions, viewing angles (i = incidence, e = emission), and spectrum number in each section of the VIRS and UVVS surface observations during the first Mercury flyby. Horizontal color bar corresponds to regions in Fig. 1.

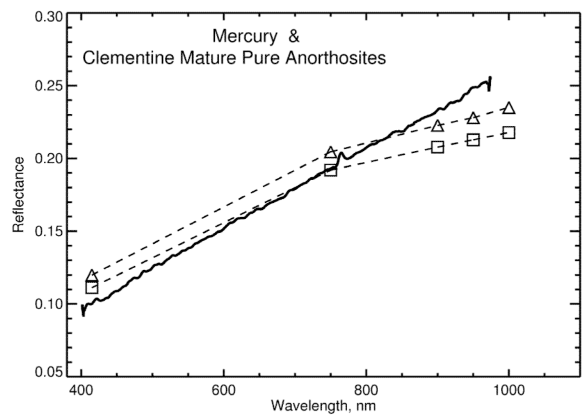

Figure. 3 Solid line: Telescopic spectrum of Mercury [17]. Dashed lines: Clementine spectra of lunar far side anorthosites [16]. The lunar spectra have very weak FeO bands but still display a slight downturn toward 1000 nm. The Mercury spectrum shows no change in slope, and its slope is steeper (redder) than the lunar examples.

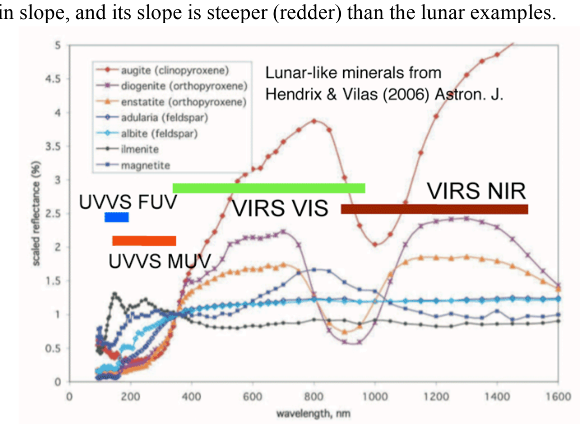

Figure 4. Spectra of lunar-like materials and the MASCS surface wavelength ranges.