THERMAL INFRARED SPECTROCOPY OF Mg-SULFIDES AT SIMULATED MERCURY'S SURFACE CONDITIONS. I. Varatharajan[1], A. Maturilli[1], J. Helbert[1], H. Hiesinger[2] [1]Institute for Planetary Research, German Aerospace Center DLR, Rutherfordstrasse 2, 12489 Berlin, Germany (indhu.varatharajan@dlr.de), [2] Wilhelms Universität Münster, Germany

Introduction: Measurements of the abundance and composition of volatiles on the surface and in the atmosphere or exosphere of a planet can provide insights to the thermal evolution of the planet itself. MESSENGER revealed that Mercury has been formed at highly reducing environment unlike Moon with high magnesium and surprisingly sulfur abudances [1].

The Mercury Radiometer and Thermal Imaging Spectrometer (MERTIS) payload of ESA/JAXA Bepicolombo mission to Mercury will study the surface mineralogy at wavelength range of 7-14 µm at spatial resolution of 500 m/pixel [2]. Studying the thermal emissivity measurements of possible Mercury analogues at Mercury surface temperatures up to 450°C will help us to create the standard spectral library for MERTIS data analysis [5].

Mercury with high-Mg and high-S abundance on its surface and potentially in its interior therefore motivates us to study the spectroscopy of magnesium sulfide (MgS), one of the possible surface representation of Mercury. Mapping the extent of MgS bulk mineralogy of the Mercury surface will also help us to identify the extent of sulphur-related volcanism on the planet, including hollows and pyroclastic deposits. The visible and near-infrared (VIS-NIR) reflectance spectra of MgS at Mercury surface conditions studied by [3] shows a distinctive absorption feature near 0.6 µm; however, this feature is diminished significantly at Mercury day time temperature. It still has been tentatively identified in the MESSENGER multi-spectral imaging data of Dominici crater [4]. Identifyng the distinctive absorption features in the spectral range of MERTIS at Mercury's surface conditions will help us to identify the spatial distribution of MgS across the surface. In this study, we report the thermal spectroscopy measurements of MgS under Mercury surface conditions.

Sample: The fine-grained synthetic MgS of 99% purity obtained from the certified industrial suppliers are used for the thermal spectroscopy study.

PEL: A Bruker Vertex 80V instrument with a MCT HgCdTe detector (cooled by liquid nitrogen) and KBr beamsplitter is used at the Planetary Spectroscopy Laboratory (PSL) to measure the Thermal infrared (TIR) emission spectra of the samples. This spectrometer is attached to an external chamber where the samples are placed in steel cups which are then heated to Mercury's daytime temperatures via induction technique under vacuum. Thermal infrared spectral studies of variety of minerals analogues to Mercury and other planetary bodies have been conducted in varying temperature conditions at PSL using this facility [5].

Methods and Results: MgS samples are heated to temperature from 200° to 500°C (step 100°C) at vacuum (of 0.7 mbar pressure conditons) and then cooled down in vacuum. The emissivity measurements are taken at temperatures of 200°C, 300°C, 400°C, and 500° C (Fig. 2). Thus the samples are now thermally processed for the Mercury's surface conditions.

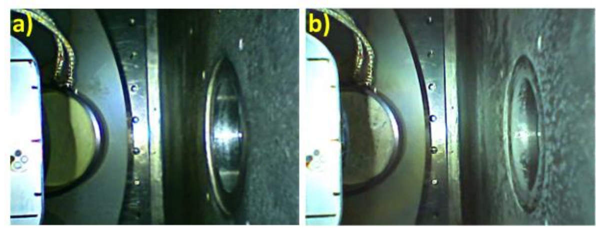

Figure 1. Sample is placed in the external chamber and its been constantly monitored via webcam. a) the sample at ambient temperature and b) sample heated to high temperature and then cooled, showing changes in the color after heating.

Radiance from the heated samples is collected by a gold (Au) coated parabolic at 90° off-axis mirror which is then reflected to the spectrometer which obtains the thermal emission spectra of the samples at wavelength intervals of 7-14 µm at spectral resolution of 4 cm^{-1}.

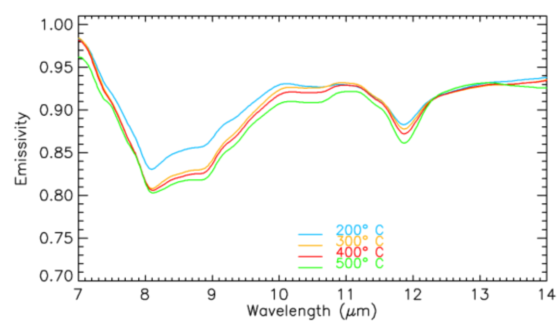

Figure 2. The TIR spectra of MgS obtained at temperatures of 200°C, 300°C, 400°C, and 500°C under vacuum of 0.7 mbar.

TIR Spectra of MgS: The thermal infrared spectra of MgS shows broad absorption feature near 8-9 µm and a strong narrow and distinctive feature near 12 µm which is also seen for elemental sulfur [6]. Irrespective of the measured radiance at different temperatures, the general spectral features do not vary and the spectral contrast remains strong at these wavelengths. The presence of MgS at the Mercury surface will be easily identified by MERTIS irrespective of the time of observation.

Discussions: The study by [3,7] suggests that MgS can be formed with Mg-rich lavas (such as komatiites) when they interact with sulfur-rich deposits forming a slag which then leads to the formation of hollows by removal of top material. However, it is difficult to identify and map these slags spectrally from MESSENGER data as MgS loses its strong spectral absorption feature near 0.6 μm at VIS-NIR spectral range (0.4-1.1 μm) during daytime surface temperature of Mercury.

In the present study we show that MgS retains its spectral contrasts even at high temperatures (up to 500°C) in the wavelength range of 7-14 μm. This suggests that MERTIS is efficient to identify and map sulfide slag deposits within the hollows and also the S-related pyroclastic deposit distribution on the suface. Thus, MERTIS will be a powerful tool to not only identify the silicate mineralogy but also to identify volatile rich minerals across the surface. Thus, MERTIS will open a new door to identify spectrally heterogeneous surface mineralogy of Mercury.

Future work: MESSENGER also suggests the presence of MnS, FeS, CrS, and TiS on the surface [8]. In order to perform spectral and compositional mapping of volatile-enriched volcanic mineralogy on the surface of Mercury using MERTIS, we will perform the similar methodology to measure the thermal infrared spectra of these pure sulfide analogues along with the mixtures at Mercury environmental conditions. Reflectance spectra from the UV to the TIR spectral range will be acquired for fresh and thermally processed samples.

References: [1] Nittler L.R. et al. (2011) Science, 333, 1847-1849. [2] Hiesinger, H. and J. Helbert (2010) Planetary and Space Science 58(1-2): 144-165. [3] Helbert J. et al. (2013) EPSL, 369-370, 233-238. [4] Vilas F. et al (2016) GRL, 43, 1450-1456. [5] Maturilli A. et al (2017) LPSC, 48th. [6] Helbert J. et al. (2015) LPSC, 46th, 1906. [7] Blewett D. T. et al. (2013) JGR, 118, 1013-1032. [8] Kadeen K. E. V. et al. (2016), Icarus, in press.