THERMAL WEATHERING OF Ca-SULFIDES AND THEIR SPECTRAL BEHAVIOR IN THERMAL INFRARED UNDER SIMULATED MERCURY ENVIRONMENT CONDITIONS.

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Introduction: Understanding the distribution and abundance of volatiles in the planet's surface helps to understand the thermal evolution of the planet itself. The Mercury Surface, Space Environment, Geochemistry, and Ranging (MESSENGER) mission revealed that Mercury (unlike the Moon) has been formed at highly reducing environment with high magnesium and surprisingly sulfur abundances [1]. There are multiple lines of evidence suggesting the presence of sulfide minerals on the surface of Mercury. Sulfides in the shallow regolith probably include major FeS and CaS [2]. MESSENGER also suggests the presence of MnS, FeS, CrS, and TiS on the surface [3]. The sulfides (CaS,MgS) are also positively detected in the Dominici crater using MESSENGER Mercury Atmospheric and Surface Composition Spectrometer (MASCS) datasets [4].

MERTIS (Mercury Radiometer and Thermal Imaging Spectrometer) will study the surface mineralogy of Mercury at wavelength range of 7-14 µm at spatial resolution of 500 m/pixel [5]. Studying the thermal emissivity measurements of possible Mercury analogues at Mercury surface temperatures up to 450°C will therefore help us to create the standard spectral library for MERTIS data analysis [6]. We have measured the thermal emissivity spectra at 7-14 µm for a wide range of sulfides in simulated Mercury conditions and obtained the corresponding reflectance spectra of both fresh and thermally weathered sulfides in 0.2-100 µm at various phase angles [7]. These measurements facilitate the detection of sulfides in available datasets from the NASA MESSENGER mission (MASCS and MDIS) and help prepare for the upcoming ESA-JAXA BepiColombo mission. Here we will get sprectral data from the MERTIS instrument and from the visible–near-infrared imaging spectrometer (VIHI) part of the Spectrometer and Imagers for MPO BepiColombo – Integrated Observatory SYStem (SIMBIO-SYS).

Calcium sulfides: Among the emissivity of sulfides studies, CaS showed strong emissivity features while heating from room temperature to 500°C and showed less susceptibility to thermal weathering. In this study, we conducted emissvity of CaS under three Mercury days to study the nature of its thermal weathering under repeated exposure of Mercury days.

The fine-grained synthetic CaS of 99% purity obtained from the certified industrial suppliers are used for this study.

Planetary Spectroscopy Laboratory (PSL): A Bruker Vertex 80V instrument with a MCT HgCdTe detector (cooled by liquid nitrogen) and KBr beamsplitter is used at the Planetary Spectroscopy

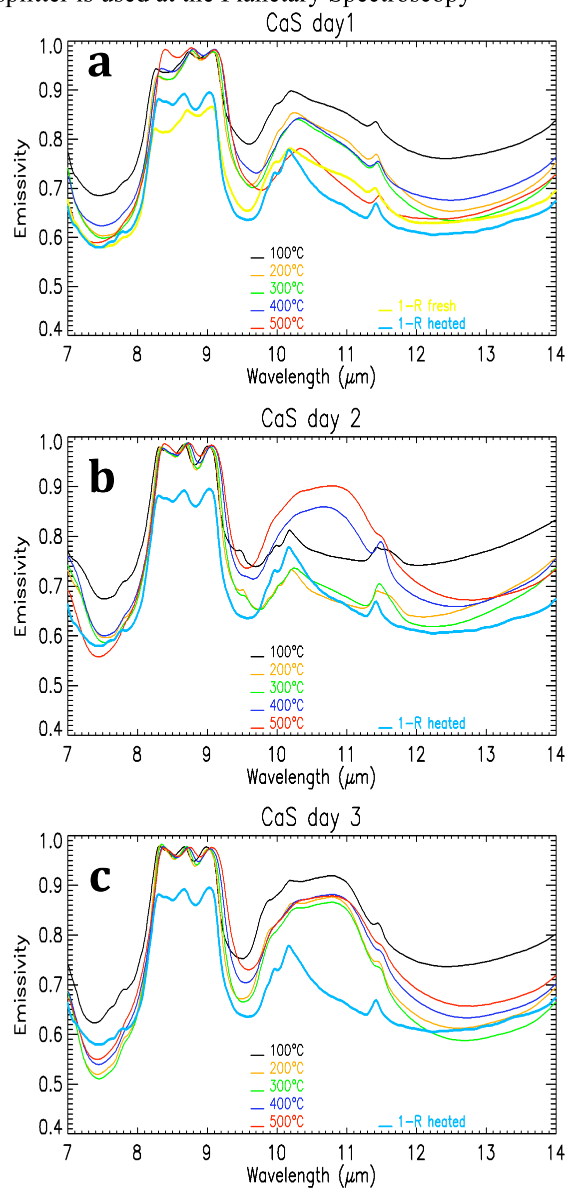

Figure 1. Emissivity of CaS under three Mercury Days. (a,b,c) shows the evolution in spectral behavior due to thermal weathering of CaS under longer exposure times

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 [6].

Methods and Results: CaS samples are heated to temperature from 100° to 500°C (step 100°C) at vacuum (of 0.7 mbar pressure conditons) and then cooled down in vacuum. 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}. The emissivity measurements are therefore taken at temperatures of 100°C, 200°C, 300°C, 400°C, and 500° C (Fig. 1a). Fig 1a shows that CaS did not undergoes significant changes in its spectral behavior while heating through one Mercury day conditions. This procedure is then repeated for a second cycle (Fig 1b) where it can be noticed that the emissvity between 9.5–12 μm varies with temperature due to thermal weathering; however, the spectral morphology between 8–9.5 μm was undisturbed due to thermal weathering. After the measurements, the sulfides are cooled down and then heated up to Mercury peak temperatures at Day 3 (Fig 1c), where CaS almost maintains its spectral behavior.

Conclusions: The study shows the importance in experimental study of thermal behavior of CaS under repeated Mercury conditions. Though CaS was thermally stable during one Mercury daytime heating conditions, the spectral behavior evolves with repeated heating. This is important to address while detecting CaS in Mercury surface which has undergone long exposure of thermal weathering conditions.

References: [1] Nittler, L.R., et al (2011) Science, p. 1847-1850. [2] Helbert, J. et al (2013). EPSL, 369–370: p. 233-238. [3] E. Vander Kaaden, K., et al. (2017). Icarus, 285: p. 155-168. [4] Vilas, F., et al. (2016). GRL, 43(4): p. 1450-1456. [5] Hiesinger, H. and J. Helbert (2010) Planetary and Space Science 58(1-2): 144-165. [6] Maturilli, A., et al. (2017) 48th LPSC, p. 1427. [7] Varatharajan, I et al (2017) 48th LPSC, p. 1398.