EPSC Abstracts
Vol. 12, EPSC2018-1092, 2018
European Planetary Science Congress 2018

Spectroscopy of minerals analogs of Mercury under the hermean conditions: The effect of the temperature

N. Bott (1), R. Brunetto (2), C. Carli (3), F. Capaccioni (3), A. Doressoundiram (1), Y. Langevin (2), D. Perna (1,4), F. Poulet (2), G. Serventi (3), M. Sgavetti (3), F. Borondics (5), and C. Sandt (5)
(1) LESIA - Observatoire de Paris - CNRS - Sorbonne Université - Université Paris-Diderot, 5 place Jules Janssen, 92195 Meudon, France, (2) Institut d'Astrophysique Spatiale - CNRS - Université Paris-Sud, Orsay, France, (3) Istituto di Astrofisica e Planetologia Spaziali - INAF, Roma, Italy, (4) Osservatorio Astronomico di Roma - INAF, Monte Porzio Catone, Italy, (5) Synchrotron SOLEIL, Saint-Aubin, France (nicolas.Bott@obspm.fr)

Abstract

We present a preliminary study to focus on the effects of the extreme conditions occurring on Mercury on minerals analogs, in particular taking into account the strong variations of temperature.

1. Introduction

A major result of the MESSENGER mission was to reveal the volcanic hermean surface poor in iron [1], but unexpectedly rich in volatile elements [2]. The high abundance of sulfur on Mercury is particularly interesting, because its sublimation is suggested to trigger the formation of hollows [3]. Laboratory experiments whose aim is to study the evolution of sulfides in the conditions of Mercury's surface are in progress [4]. However, to understand the spectral properties of the surface need to consider how minerals can be affected by the hermean environment. The effects of temperature and space weathering on minerals have been already studied [5,6] but rarely on Mercury's analogs [7].

2. Samples and setups

We began our activities measuring a loose powder (75-100 µm) of plagioclase Pl3 [8] and 5 mm diameter pellets with the same plagioclase powder. To simulate the hermean high T conditions, we used a LINKAM (nitrogen purged) cell to heat and cool our samples which allows to measure VIS-IR (0.4-15 µm) spectra as a function of temperature (298-623K in our case). Finally, we used two setups for our spectroscopic analyses: 1) a visible-near infrared spectrometer Maya2000 Pro coupled with a microscope through optical fibers; 2) a near to mid infrared spectrometer coupled with an Agilent microscope, installed at the SMIS (Spectroscopy and Microscopy in the Infrared using Synchrotron) beamline of the synchrotron SOLEIL.

3. Analytical method

In a typical heating experiment, the powder or the pellet was placed inside the purged heating cell and reflectance spectra were recorded every 50K of increasing temperature. The heating ramp was 5K/min, with a 10-20 min plateau to record the spectrum at a given temperature. A similar cooling cycle was then performed and spectra were measured as a function of decreasing temperature from 623K to 302K.

4. Preliminary results

Figure 1 shows the thermal infrared where the Christiansen feature (CF) and the Reststrahlen absorption bands (RB) of silicates are studied.

A preliminary qualitative analysis showed a shift towards greater wavelengths for several RB peaks (e.g. at ~9.0 and ~10.5 µm) as a function of increasing T, whereas the CF does not shift. A more quantitative analysis will be presented and discussed.

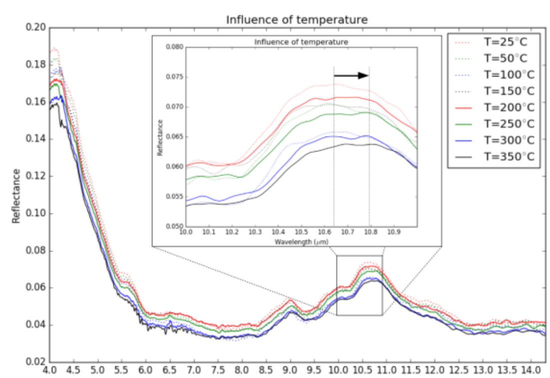

Fig. 1. Mid infrared spectra of a pellet of plagioclase taken at different temperatures (from 298 K to 623 K).

5. Future activities

In the next future, we plan to perform more heating experiments to study the evolution of natural minerals, as well as synthetic Mercury-like glasses [7] at temperature during day time. In addition, we consider to take measurements in cold conditions as it is the case on the floor of polar craters of Mercury. Finally, we plan to irradiate our samples with 40 keV ion beams with different fluences as a simulation of slow solar wind irradiation of Mercury.

Acknowledgements

This work is partly supported by the Centre National d'Études Spatiales. The microspectroscopy activities are supported by grants from Région Ile-de-France (DIM-ACAV) and SOLEIL. D. Perna received funding from the European Union's Horizon 2020 research & innovation program under the Marie Sklodowska-Curie grant agreement n.664931

References

[1] Peplowski P. N. et al.: Mapping iron abundances on the surface of Mercury: Predicted spatial resolution of the MESSENGER Gamma-Ray Spectrometer, Planetary and Space Science, Vol. 59, pp. 1654-1658, 2011.

[2] Nittler L. R. et al.: The Major-Element Composition of Mercury's Surface from MESSENGER X-ray Spectrometry, Science, Vol. 333, pp. 1847-1850, 2011.

[3] Blewett D. T. et al.: Mercury's hollows: Constraints on formation and composition from analysis of geological setting and spectral reflectance, Journal of Geophysical Research, Vol. 118, pp. 1013-1032, 2013.

[4] Varatharajan I. et al.: Emissivity of Ca-Sulfide in Mid-Infrared Under Simulated Extreme Thermal Environment of Mercury, LPI abstract #2047, 2018.

[5] Suto H. et al.: Low-temperature single crystal reflection spectra of forsterite, Monthly Notices of the Royal Astronomical Society, Vol. 370, pp. 1599-1606, 2006.

[6] Brunetto R. et al.: Ion irradiation of Allende meteorite probed by visible, IR, and Raman spectroscopies, Icarus, Vol. 237, pp. 278-292, 2014.

[7] Morlok A. et al.: IR spectroscopy of synthetic glasses with Mercury surface composition: Analogs for remote sensing, Icarus, Vol. 296, pp. 123-138, 2017.

[8] Serventi G. et al.: Spectral variability of plagioclase-mafic mixtures (1): Effects of chemistry and modal abundance in reflectance spectra of rocks and mineral mixtures, Icarus, Vol. 226, pp. 282-298, 2014.