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Examining the effects of both heating and irradiation on minerals analogs of Mercury

Nicolas Bott (1), Rosario Brunetto (2), Alain Doressoundiram (1), Cristian Carli (3), Fabrizio Capaccioni (3), Yves Langevin (2), Davide Perna (4), François Poulet (2), Giovanna Serventi (3), Maria Sgavetti (3), Francesco Vetere (5), Diego Perugini (5), Cristina Pauselli (5), Giovanni Strazzulla (6), Ferenc Borondics (7), and Christophe Sandt (7)
(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, Rome, Italy, (4) Osservatorio Astronomico di Roma – INAF, Monte Porzio Catone, Italy, (5) Department of Physics and Geology, University of Perugia, Perugia, Italy, (6) Osservatorio Astrofisico di Catania – INAF, Catania, Italy, (7) Synchrotron SOLEIL, Saint-Aubin, France (nicolas.Bott@obspm.fr)

Abstract

We present for the first time the effects of both heating and swift heavy ion irradiation on selected minerals (plagioclase, olivine) and volcanic glasses which could be expected on the surface of Mercury.

1. Introduction

Thanks to MESSENGER, we know that the surface of Mercury is mainly volcanic, poor in iron [1], but unexpectedly rich in volatile elements [2]. The BepiColombo mission has been launched the 19th October 2018 towards Mercury, with two onboard instruments (SIMBIO-SYS [3] and MERTIS [4]) whose aim is to better understand the nature and the evolution of its surface. To prepare their observations, it is crucial to understand 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 retrieved Mercury's composition [7]. Here we present the effects on minerals of extreme variations of both temperature and irradiation occurring on Mercury.

2. Samples and setups

We considered three plagioclase (An_{80}) samples [8] under different states (powder, pellet and slice), a pellet made of a powder of volcanic glasses [9] and four olivine (Fo_{90}) samples [10,11] half covered by a thin layer of carbon and irradiated at GANIL-IRRSUD (Caen, France) with 88 MeV $^{126}Xe^{23+}$ ions with different fluences (0, 10^{11}, 10^{12} and 10^{13} ions/cm^2).

To simulate the hermean high temperature conditions (80-700 K), 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. We have two setups for our spectroscopic measurements: 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. Results

Figure 1 shows an example of thermal infrared spectra of the three irradiated samples of olivine. The spectral effects of temperature and irradiation are clear: 1) decrease of global reflectance; 2) shift, 3) decrease of depth and 4) change in shape of the absorption bands. These spectral effects are in agreement with previous studies conducted on other samples [5,6] More results and discussion will be presented.

4. Future activities

We plan to heat our samples for a longer period of time (several hours) to determine if the spectral effects of heating reach a saturation regime like it does for space weathering. We also consider to take more resolved spectra (e.g. 2 cm^{-1}) and do heatings with smaller step (each 10°C) to evidence more clearly the spectral changes observed.

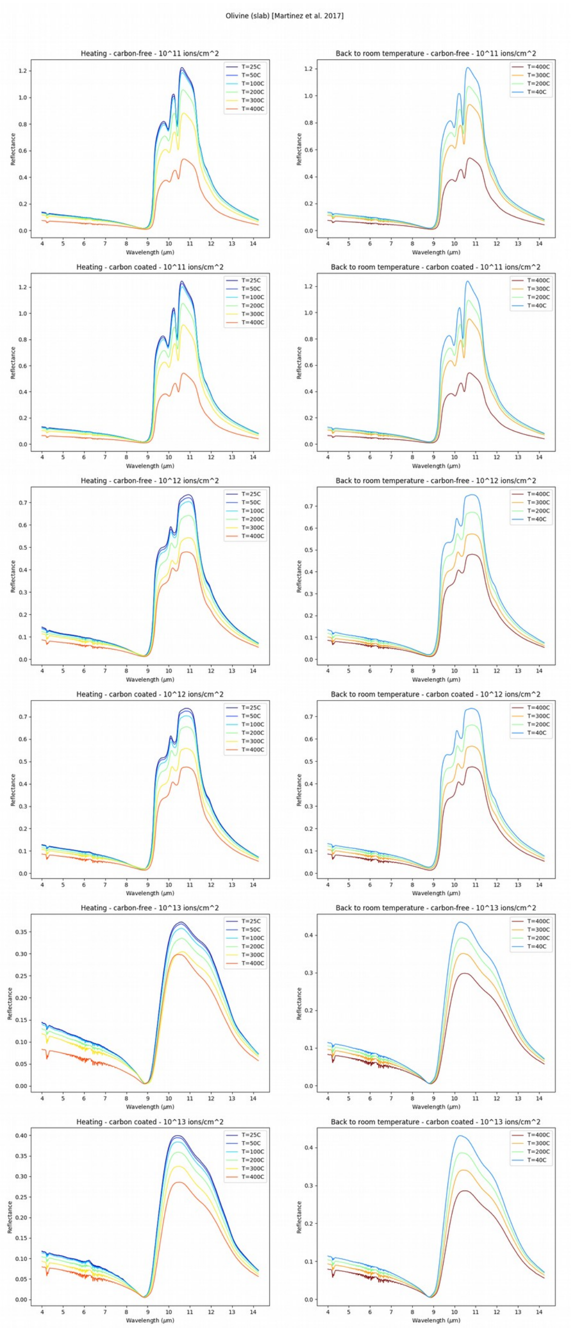

Figure 1: TIR spectra of the three irradiated samples of olivine taken at different temperature (25-400°C).

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