Geophysical Research Abstracts
Vol. 19, EGU2017-7375, 2017
EGU General Assembly 2017

Temperature-dependent VNIR spectroscopy of hydrated Na-carbonates

Federico Tosi (1), Cristian Carli (1), Simone De Angelis (1), Pierre Beck (2), Olivier Brissaud (2), Bernard Schmitt (2), Fabrizio Capaccioni (1), Maria Cristina De Sanctis (1), and Giuseppe Piccioni (1)

(1) INAF-IAPS, Rome, Italy, (2) IPAG UGA/CNRS Grenoble, France

The surfaces of the Galilean icy satellites Europa, Ganymede and Callisto, dominated by water ice, also show substantial amounts of non-water-ice compounds. These satellites will be the subject of close exploration by the ESA JUICE mission and the NASA Europa Multiple-Flyby Mission, which will focus on Ganymede and Europa, respectively. Among non-water-ice compounds thought to exist on the surfaces of the Jovian icy satellites, hydrated salt minerals have been proposed to exist as a by-product of endogenic processes. Safe detection of these minerals shall rely on laboratory spectroscopic analysis of these materials carried out under appropriate environmental conditions.

Here we report on laboratory measurements, carried out in the framework of a Europlanet Transnational Access (TA) 2020 proposal approved in 2016, on two hydrated sodium carbonates, namely sodium carbonate monohydrate ($Na2CO_3 \cdot 1H_2O$) and sodium carbonate decahydrate ($Na2CO_3 \cdot 10H_2O$). Spectral profiles of these compounds were obtained in the visible and near-infrared (VNIR) spectral domain, taking advantage of the Cold Surfaces spectroscopy facility at the Institut de Planétologie et d'Astrophysique de Grenoble (IPAG), where such compounds can be measured under cryogenic conditions indicative of real planetary surfaces. Carbonates were first sieved so as to separate them in three different grain size ranges: 20-50 μm, 75-100 μm, and 125-150 μm. These grain sizes have been chosen to: (1) be indicative of typical regoliths known or expected to exist on the surface of the icy satellites, and (2) avoid overlapping between ranges, therefore minimizing particles contamination among the dimensional classes. Each grain size was then measured with the Spectro-Gonio-Radiometer facility in the overall 0.5-4.0 μm spectral range, with spectral sampling increasing with increasing wavelength. For each sample, the overall 93-279 K temperature ramp was acquired in 11 steps varying from 10 K to 25 K, imposed by time constraints. In particular, the uppermost temperature, 279 K, has been acquired both at the beginning and at end of the ramp, to check for any macroscopic physico-chemical changes in the sample.

In sodium carbonate monohydrate, about ten spectral signatures are revealed in the spectral range 1.0-3.0 μm. These signatures are due in part to combinations and overtones of the fundamental vibration modes of the water molecule, and in part to the carbonate. For comparison, sodium carbonate decahydrate shows fewer diagnostic and generally wider signatures, due to the larger number of water molecules existing in this mineral.

We analyzed the spectral behavior of the diagnostic signatures of these two hydrated minerals as a function of both grain size and temperature, deriving trends related to specific spectral parameters such as band center, band depth, band area, and bandwidth. We plan to complete this set of measurements with those obtained for anhydrous sodium carbonate, which serves as a valid comparison for the hydrated carbonates discussed here and may provide a valid support to spectroscopic analysis of bright faculae discovered by the NASA Dawn mission in crater Occator on the dwarf planet Ceres.