

VNIR reflectance spectroscopy of glassy igneous material with variable oxidation states

Cristian Carli (1), Danilo Di Genova (2), Ted L. Roush (3), Werner Ertel-Ingrisch (4), Fabrizio Capaccioni (1), and Donald B. Dingwell (4)

(1) IAPS - INAF, Rome, Italy (cristian.carli@iaps.inaf.it), (2) School of Earth Sciences, University of Bristol, Bristol, United Kingdom, (3) NASA Ames Research Center, Moffett Field, CA, USA, (4) Department Earth and Environmental Sciences, Ludwig-Maximilians-Universität, München, Germany

Silicate glasses with igneous compositions may represent an abundant component of planetary surface material via effusive volcanism or impact cratering processes. Several planetary surfaces are mapped with hyper-spectrometers in the visible and near-infrared (VNIR). In this spectral range, crystal field (C.F.) absorptions are useful to discriminate iron-bearing silicate components. At the same time, in the VNIR reflectance spectroscopy iron bearing glasses may exhibit a C.F. absorption at $\sim 1.1 \mu\text{m}$. A weak C.F. absorption is also present at $\sim 1.9 \mu\text{m}$. These absorptions can be therefore diagnostic for glassy component and can also affect the C.F. absorptions of mafic minerals when mixed in the regolith.

So far, few studies investigated the spectral properties of systematic glasses compositions and at different oxygen fugacity. For these reasons studying glassy materials, and their optical constants, represents an important effort to document and to interpret, spectral features of Solar System silicate crusts where glasses are present, but may be difficult to map.

In previous work Carli et al. (2016) considered the composition of glassy igneous materials produced in Earth-like atmospheric conditions (i.e. oxidized conditions). Here, we expand on that effort by including glasses formed under more reducing condition. In this study, glasses were produced at $-9.3 \log f\text{O}_2$ and 1400°C for a duration of 4 h at the Department of Earth and Environmental Sciences at the University of Munich using a gas-mixing furnace. The major element composition, sample homogeneity, and the $\text{Fe}^{3+}/\text{Fe}_{\text{tot.}}$ ratio of run products were analytically determined. Moreover, Raman spectra of the same samples were also acquired.

Afterwards, powders were produced with nine-grain size from $250\text{-}224 \mu\text{m}$ to $50\text{-}20 \mu\text{m}$ and measured in bidirectional reflectance at Spectroscopy LABORatory (IAPS-INAF, Rome). Reflectance spectra were acquired from 0.35 to $2.5 \mu\text{m}$ with a Field-Pro Spectrometer mounted on a goniometer. Spectra were obtained with incident and emission angles of 30° and 0° , respectively. Spectra showed both diagnostic bands, reflectance diminished with increasing iron abundance. The comparison with spectra collected from samples synthesized at “Earth-like” atmospheric conditions showed:

- 1) Relatively higher reflectance in the visible; 2) less red slope in the IR; 3) deeper $1.1 \mu\text{m}$ absorption band.

Following Carli et al. (2016, Icarus), for all the spectra acquired at each grain size, we apply the radiative transfer model to estimate the optical constant as a wavelength's function. Finally, we will report the retrieved optical constants for our samples and we will compare them with those obtained from the same composition but at “Earth-like” atmospheric conditions.

Reference: Carli et al. 2016, Icarus, doi:10.1016/j.icarus.2015.10.032.