VNIR SPECTRAL VARIABILITY OF Northwest Africa 6232 OLIVINE-DIOGENITE.

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Introduction: 4Vesta asteroid is supposed to be the parental body of Howardite, Eucrite and Diogenite (HED) meteorites. These achondrites show igneous-like characteristics (e.g. composition, texture) and display visible and near-infrared (VNIR) spectra analogue to those of Vesta's asteroid family (e.g. [1]). Recently, the Dawn Mission (NASA) has investigated 4Vesta from the orbit, producing a first detailed global mapping. This mission has confirmed that the whole body is characterized by spectra compatible with HEDs [2], revealing the two dominating pyroxenes absorptions, around 1 and 2 μm [3]. In particular, spectral characteristics are within the Howardites field, and, partially, within those of Eucrites and Diogenites [4]. Moreover, bright and dark materials are visible, which are, probably, fresher excavated [5] and CC-like materials-rich regions [6], respectively. [7] identified areas where the olivine could be present in significant amounts in two craters of the north hemisphere, and [8] indicated that olivine could be present also in other regions. Unexpectedly, no evidence for olivine was detected in RheaSilvia Basin, where diogenites are clearly present [4] and the mantle could be exposed.

Here we present spectral characteristics of an olivine diogenite, Northwest Africa 6232 (NWA6232) [9], belonging to the Museo di Storia Naturale dell'Università di Firenze (sample RI-3225). We considered the variability in reflectance and absorptions of a slab (fresh-cut surface) comparing these data with pyroxene and olivine compositions. We analyzed how absorptions change on different area on the surface of the sample. In particular, we measured a crossing from out to in an olivine grain. Moreover we discuss how to extrapolate the olivine relative abundance respect to the surrounding materials by using spectral parameters.

Methods: Reflectance spectra were measured on a slab sample. The measured surface was cut but not mirror-like polished. The bidirectional reflectance spectra were measured with a Fieldspec-Pro spectrophotometer mounted on a goniometer in use at the SLAB (Spectroscopy LABoratory) at IAPS-INAF, Rome. The spectra were acquired with 1 nm spectral sampling between 0.35 and 2.50 μm with i=30° and e=0°. The source used was a QTH lamp. The calibration was performed with Spectralon optical standard (registered trademark of Labsphere, Inc.). The illuminated spot was ca. 0.5 cm^2. The mineral chemistry of selected mineral phases (e.g. pyroxenes, olivine) was analyzed by means of EMPA in order to quantify their major and minor elements' contents. EMPA-WDS analyses were performed at the IGG-CNR (Firenze) with a Joel Microbeam microprobe. The mineral chemistry is related to spectral parameters.

Results: Spectra show a mean reflectance between 0.1-0.15, and mafic minerals are clearly indicated by the presence of Fe^{2+} crystal field absorptions around 1 and 2 μm (Fig.1). In general, both the mafic absorptions indicative of pyroxenes are clearly present in the spectra with a variation in spectral contrast, also correlated with a flattening between 1.1 and 1.5 μm (see Fig.1). Moreover few spectra around one bigger clast show a wider, longer-wavelength shifted, 1 μm absorption, and a very weak 2 μm absorption. These spectra clearly indicate the presence of olivine, confirmed by optical microscope and EMPA data.

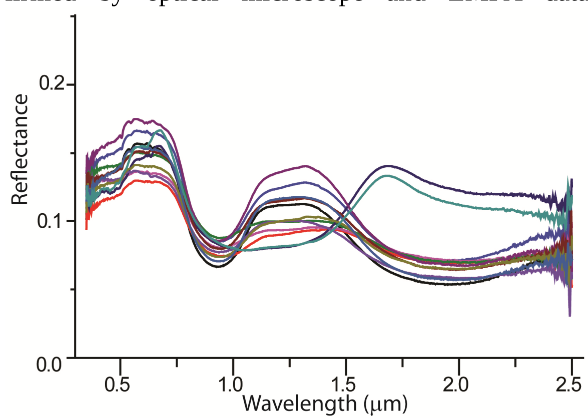

Figure 1 - Different bidirectional reflectance spectra acquired on the NWA6232 slab surface.

We analyzed in more details the spectral relationship between this olivine and the surrounding material, measuring several spectra from outside to inside the clast. A set of 12 spectra were acquired, spaced by 1 to 0.5 mm, to vary the olivine amount present in our measurements. In this first step we analyzed spectral parameters with a particular attention to the depth and the center of 1μm absorption. These parameters were acquired for each spectrum after the removal of continuum performed according to the approach described in [10]. Figure 2 shows the spectral characteristics of some selected spectra after continuum removal. Pyroxene-rich and olivine-rich spectra clearly show a different behavior, whereas a set of spectra show a widening of the pyroxene's 1μm band.

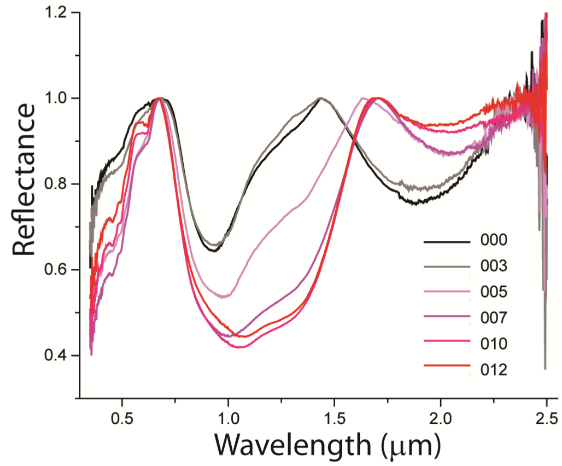

Figure 2 - Selected continuum removed spectra acquired on a olivine clast (red) partially filled (pink) on diogenitic matrix (black).

Moreover, olivine absorption is more intense (deeper) than piroxene's absorptions. The variation of this shorter wavelength absorption with the variation of the olivine area in the illuminated spot is also clearly highlighted by the shift of the band center. Figure 3 shows how, varying the areal % of olivine in the illuminated portion, the center of the 1 μm band moves towards longer wavelengths, from 0.93 μm to 1.09 μm.

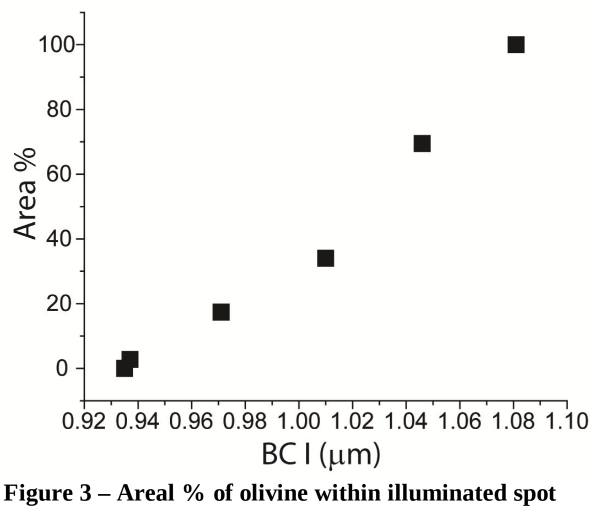

Figure 3 – Areal % of olivine within illuminated spot Vs. Band Center wavelength.

Future Works: The variation of the Band Center seems to be well correlated in this case with the variation of olivine amounts within the illuminated spot. We are working to better understand the olivine detection limit considering also linear unmixing methods, Gaussian deconvolution models and/or radiative transfer models. Moreover we are planning to measure also powder spectra of this meteorite as well as possibly mixing with opportune olivine's composition.

References:

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