PETROLOGICAL, GEOCHEMICAL AND SPECTRAL LABORATORY STUDIES OF TERRESTRIAL FELDSPATHIC ROCKS: UNDERSTANDING PLAGIOCLASE SIGNATURES IN THE VNIR DOMAIN AS AN ANALOG TO MARS M. Barthez[1], J. Flahaut[1], M. Guitreau[2], G. Ito[1] and R. Pik[1]. [1]Centre de Recherches Pétrographiques et Géochimiques, Université de Lorraine, CNRS UMR-7358, F-54501 Vandœuvre-lès-Nancy, France. (marie.barthez@univ-lorraine.fr), [2]Laboratoire Magmas et Volcans, Université Clermont Auvergne, OPGC, CNRS UMR-6524, IRD UMR-163, F-63000 Clermont-Ferrand, France.

Introduction: Feldspar plagioclase is a common mineral found in many terrestrial rocks, and that has recently been detected on the surface of Mars with visible near-infrared (VNIR) spectroscopy [1-7]. These detections were made using primarily instruments onboard Martian satellites and rovers. The use of (VNIR) reflectance spectroscopy makes it possible to determine the mineralogical composition of the rocks on the surface of Mars by studying their reflectance spectrum. Determining the presence of plagioclase using this method requires the incorporation of Fe^{2+} in its chemical composition, leading to the presence of an absorption band centered around 1.3µm on its reflectance spectrum [8].

Previous laboratory studies carried out on mixtures of binary powders showed that the spectral signature of plagioclase is no longer visible when 10% or more of mafic minerals are added [9-10]. According to these studies, a minimum of 90% plagioclase feldspar content is necessary in the rock composition for its spectral signature to be visible on the total rock spectrum. Yet, a different study using a binary mixture of large plagioclase and pyroxene crystals [11] showed that up to 50% of mafic minerals could be needed to hide the plagioclase spectral signature. The key point shown by [11] was that feldspar composition but also the size of the grains and the associated minerals in the rock influence the spectral signature of plagioclase feldspars. Thus, the analysis of whole (uncrushed) rocks appears to be extremely relevant, in addition to previous studies of binary mixtures of powders and grains, for comparisons with Mars remote sensing observations that have shown plagioclase-like signatures [1-7].

Methods: Laboratory measurements of VNIR reflectance spectra, petrographic and geochemical characterizations were conducted on five macroscopic rock samples containing feldspars (*Figure 1*). They were chosen because they reflect the first order terrestrial magmatic variability from mafic to felsic and from eruptive to plutonic : two basalts, one dacite, one granite and one anorthosite. The instruments used to characterize the samples were first optical microscope and Scanning Electron Microscope (SEM) to determine the mineralogical composition of the samples, then an Electron Probe MicroAnalyzer (EPMA) to determine the chemical composition of feldspar crystals contained into each sample, and finally a point-spectrometer and hyperspectral cameras to determine the total rock spectrum and the spectrum of each mineral, respectively, into each sample.

Results: The main result of our study is that the plagioclase spectral signature is visible in total rock spectra of macroscopic rock samples of varied nature (*Figure 2*) that do not contain more than 90% of plagioclases, contrary to what was emphasized by previous studies. Also, the position of the plagioclase absorption band varies depending on the composition of the rock and the plagioclase An content, although they are not the only factors that influences it (*Figure 3*). Our results demonstrate that grain size, plagioclase composition, associated minerals, must all be taken into account when interpreting VNIR spectral signatures of plagioclase [12]: this finding has strong implications for the recent mineral detections made on Mars.

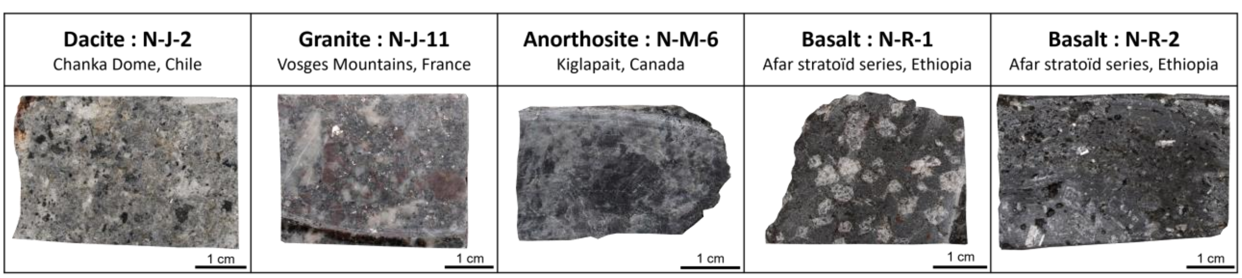

Figure 1: *The five macroscopic samples of terrestrial feldspar-bearing rocks cut as regular pieces of about four by three centimeters. Left to right: dacite N-J-2 (Chanka Dome, Chile; [13-14]), granite N-J-11 (Vosges Mountains, France; [15]), anorthosite N-M-6 (Kiglapait, Canada; [16]), basalts N-R-1 and N-R-2 (Afar, Ethiopia; [17]).*

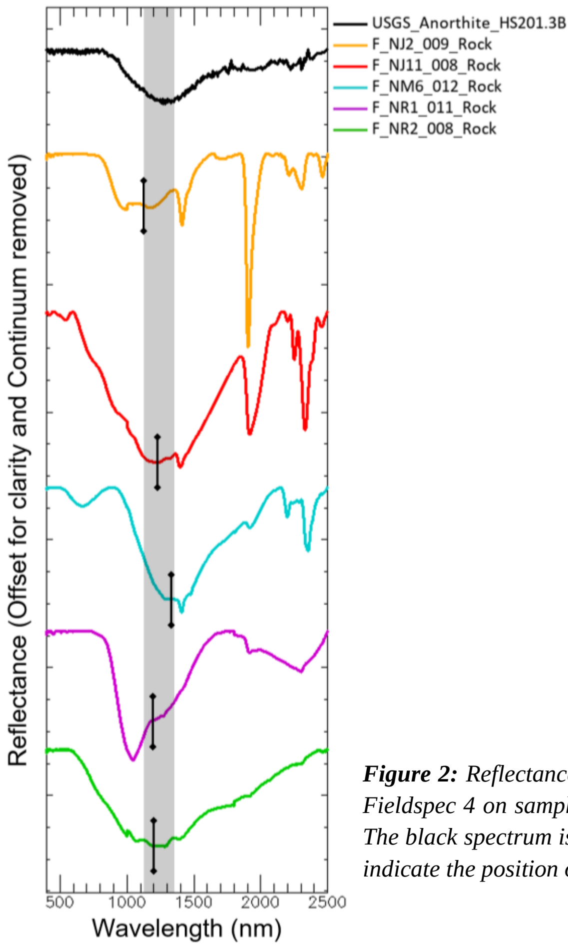

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Figure 2: *Reflectance spectra after continuum removal. Data were acquired with the ASD Fieldspec 4 on samples N-J-2, N-J-11, N-M-6, N-R-1, and N-R-2 as macroscopic samples. The black spectrum is the USGS Anorthite HS201.3B given for reference. The black arrows indicate the position of the center of the ~1.3 µm absorption band.*

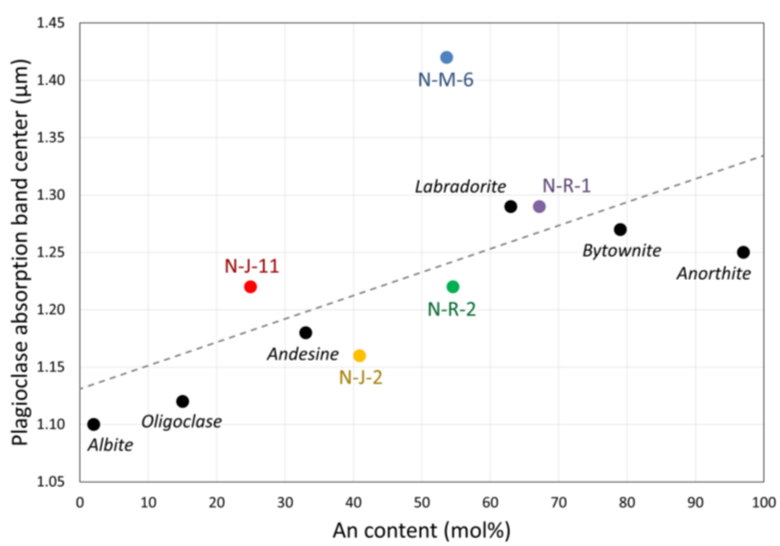

Figure 3: *Thin sections of the five felsdpathic rock samples (N-J-2, N-J-11, N-M-6, N-R-1 and N-R-2) were analyzed using the EPMA to determine the chemical composition of feldspar crystals and more precisely the anorthite (An) content of plagioclases. In parallel, the average spectrum of plagioclases contained in each sample was determined from classifications performed on VNIR and SWIR hyperspectral data cubes. The plot displays the position of the plagioclase absorption band center as a function of An content of plagioclase feldspars. The black data points were extracted from the previous study of [8].*