GLOBAL HYPERSPECTRAL CUBE OF THE MARTIAN SURFACE. L. Riu[1], F. Poulet[1], J. Carter[1], J. Audouard[1], J-P. Bibring, B. Gondet, Y. Langevin, [1]Institut d'Astrophysique Spatiale,Université Paris-Sud, 91405 Orsay cedex, France. Contact: lucie.riu@ias.u-psud.fr

Introduction: The imaging spectrometer OMEGA on board Mars Express has provided several insights on the surface and the atmosphere of Mars. The VNIR (visible and near-infrared) cube images acquired within the last 10 years enable the building of global maps of key minerals presented in [1] and [2] using independent OMEGA observations for each pixel. Following those previous global studies, the next objective is to create a 3-D global image cube of 32px/° with a surface coverage of ~90%. This product has several advantages. First, it allows to extract atmospheric- and aerosol-corrected NIR spectrum from any location of Mars. Second, several new data maps can be envisioned as discussed here. That includes new global mineral distributions, quantitatve mineral abundance distributions and maps of Martian surface chemistry (wt % oxide). A comparison with global maps of mineral abundances by TES (Thermal Emission Spectrometer) [3] and chemical composition by GRS (Gamma Ray Spectrometer) [4] is foreseen.

We here present the method to derive the global hyperspectral cube from several hundred millions of spectra. Global maps of some mafic minerals are then shown, and compared to previous works. Regional maps of mineral abundances derived from a radiative transfer model are also presented. Such mineral abundance maps will eventually allow the computing of chemical composition.

Dataset: We use OMEGA reflectance spectra in the near-infrared ranging from 0.97 µm to 2.5 µm (the so-called C-channel), corrected from the atmospheric and aerosols contribution using the model developed by [5]. This OMEGA dataset corresponds to a total of ~9000 data cubes acquired over 3.6 Martian years. A series of filtering processes was applied, excluding cubes presenting instrumental artifacts (spurious pixels) and/or surface (water and CO_2 ice) and atmospheric unfavorable observationnal conditions. 3716 data cubes were finally selected and used for deriving the global hyperspectral cube.

Methods: The 3-D global image cube of Mars is obtained from the merging of the processed data cubes. The OMEGA C-channel was impacted over the years by cosmic rays. The obtained spectrum at a given location is the result of the weighted average of every spectrum acquired during different OMEGA observations that overlap this location. During this averaging process, a weight has been applied to each spectrum according to a "quality" criterion that depends on the number of viable spectels over the total of spectels (128 for the C-channel). To obtain the maximum coverage of the surface, all observations were kept, hence images with differents spatial resolution (from 500m/px to 5km/px) were merged.

By using this approach, a 3-D map of Mars from 60°N/60°S, 0.97µm to 2.5µm, with 32px/° resolution is computed allowing local and regional studies.

Global mineral mapping: Different mineralogical maps of mafic minerals (pyroxene and olivine (Figure 1)) as well as albedo were derived from this map using spectral parameters tested and developed in [1] and [2]. The spectral indexes are based on the shape and position of key absorption bands of pyroxene and olivine.

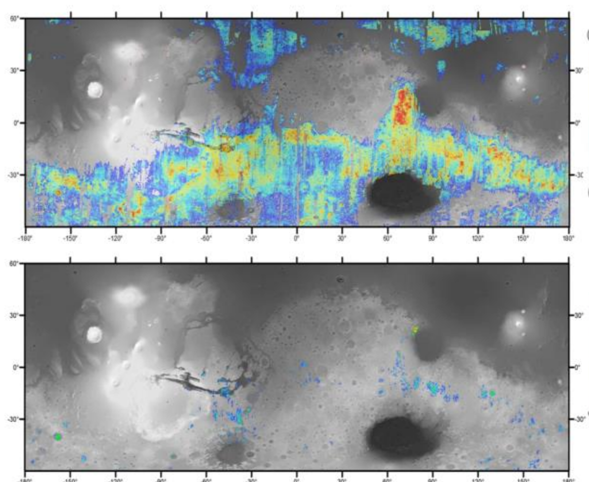

Figure 1. *Global maps (60°N/60°S) derived from the 3-D global hyperspectral map.* ***(top): pyroxene spectral index; (bottom) : olivine spectral index***.

Those maps present a higher signal to noise ratio and are less-likely to show false detections than the previous ones ([1] and [2]). Moreover the spectra used are corrected from aerosols contribution providing an additional correction compared to the previous studies. Other spectral indexes can be easily implemented to compute maps of other mineral phases. A high-calcium and low-calcium pyroxene maps based on spectral index developed by [6] are for instance shown on Figure 2.

We can see that the spatial distribution of HCP is well correlated with areas exhibiting the strongest signatures shown on Figure 1. LCP is by contrast significantly less widespread, and is more frequently found in older terrains. Some detections, especially in the northern latitudes, are not identified on the LCP and HCP maps. Further analyses have to be carried out in order to quantify those differences.

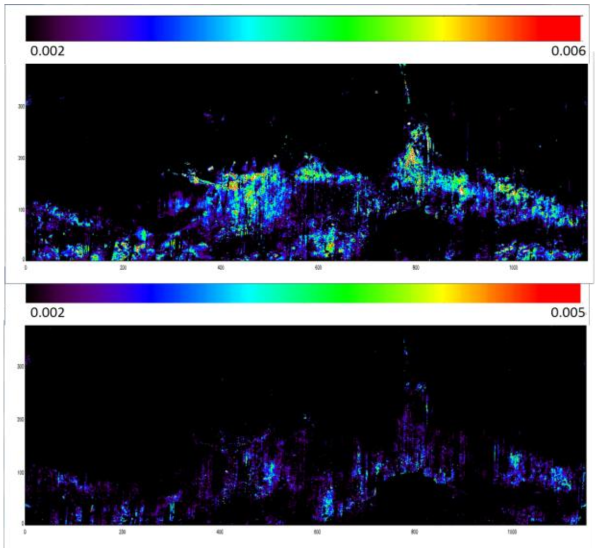

Figure 2. ***(top): HCP spectral index; (bottom): LCP spectral index.***

Modal mineralogy mapping: The next application from the hyperspectral image cube of Mars is the modelling of abundances of the minerals mapped beforehand. This study can provide abundance maps at global scale. It is important to note that this modelling is time-consuming as it requires the use of a radiative transfer model. Up to now, such an approach has been restricted to a small part of Terra Meridiani in order to validate the approach. The selected spectra to be modelled correspond to those exhibiting a pyroxene spectral index greater than 0.01, which is the threshold established by [1] for unambiguous presence of pyroxene. Previous work of modelling abundances have already been tested in this region by [6] using OMEGA spectra, which enable a comparison with this work.

The modelling of the mineral abundances in Terra Meridiani was made according to the Skuratov spectral albedo model of particulate surface [7], using five end-members : high-calcium and low-calcium pyroxenes, olivine, neutral component (plagioclase with iron oxides grains embedded in the matrix) and dust. The preliminary results showing the modelled abundances for the different end-members are presented in Figure 3.

We confirm that the surface composition is dominated by plagioclase and pyroxenes. The dust abundance distribution is not shown but it is lower than 10 vol. %. Those first results are quantitatively consistent with previous studies [6].

This method will be applied shortly at a global scale as well as to hydrated deposits.

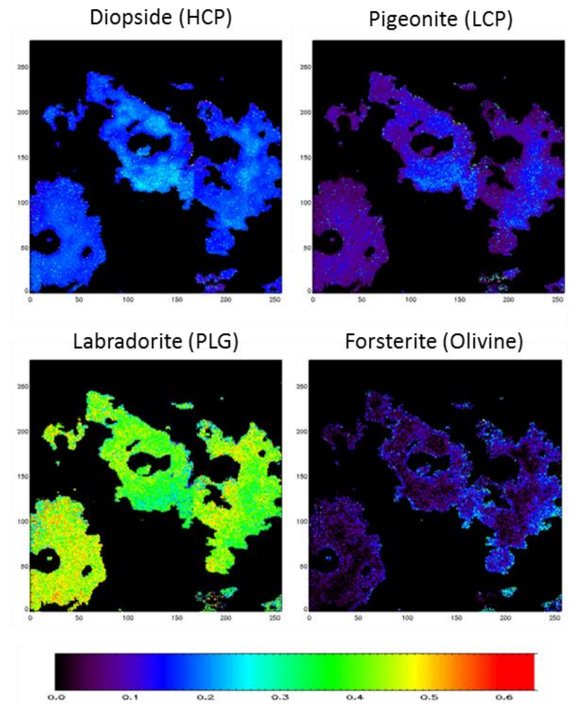

Figure 3. *Abundances (vol%) of mafic minerals in the Terra Meridiani region.*

Chemical composition mapping: Maps of chemical composition of the Martian surface have never been computed from the OMEGA dataset. In order to create those chemical composition maps, the abundances maps will be used to predict the chemical composition according to the mineral abundances found on the surface. More specifically, volumetric abundances of each identified phase in a pixel can be converted to weight percent by dividing by the density associated with that phase and normalizing fractions to 100%. Wt % oxides for each phase are then multiplied by the modelled volume fraction of that phase and combined to produce the derived “whole rock” chemistry for each pixel. In doing so, we shall be able to quantitatively compare the OMEGA data with chemistries measured by remote sensing (GRS, TES), in situ and in Martian meteorites and to consider the implications for primary igneous and weathering trends [e.g. 8].

References: [1] Ody et al., 2012, *JGR*, 117, E00J14. [2] Poulet et al., 2007, *JGR*, 112, E08S02. [3] Bandfield et al., (2000), *Science*, 287. [4] Boynton et al., (2007), *JGR*, 112. [5] Vincendon et al., 2007, *JGR*, 112, E08S13. [6] Poulet et al., (2009a), *Icarus*. [7] Skuratov et al., (1999), *Icarus*, 137. [8] McSween et al., (2009), *Science*, 324.