MAFIC MINERALOGY OF MARTIAN METEORITES BASED ON A SYSTEMATIC DECONVOLUTION USING AN IMPROVED MODIFIED GAUSSIAN MODEL (MGM) APPROACH. P.C. Pinet[1], H. Clenet[1], F. Heuripeau[1], S.D. Chevrel[1], C. Rosemberg[1], Y. Daydou[1], M. Toplis[1], D. Baratoux[1], [1]UMR 5562 / DTP / CNRS, Observatoire Midi-Pyrénées, Université Paul Sabatier, Toulouse, France (pinet@dtp.obs-mip.fr)

Introduction: Mineralogical composition is essential for the understanding of planetary evolution. In this respect, detection, identification and quantification of the relative abundance of mafic minerals, such as olivine and pyroxenes, can be used to evidence crustal or mantle petrology. Owing to Fe^{2+} electronic transitions, hyperspectral remote sensing in visible/near-infrared delivers very useful information for characterizing the petrology of igneous rocks [1,2].

Methodology: To deconvolve hyperspectral data, we use the Modified Gaussian Model (MGM) originally developed by Sunshine et al. [3]. MGM technique aims at deconvolving the absorption bands in reflectance spectra. It is achieved considering a sum of Gaussian functions and assuming that the spectral continuum can be modelled by a polynomial shape. Here we approximate the continuum by means of a degree 2 polynomial in wavelength term to deal with variable shapes of spectra, including negative slopes. Extending work of [4], the starting values for the continuum are derived on the basis of a spectral shape smoothing analysis, determining the relevant local maxima along the spectrum. Each Gaussian function (characterized by its band centre, width and strength) or combination of Gaussians permits the identification of a mineralogical absorption band, indicative of the presence of the predominant mafic minerals [5,6]. Moreover, band intensity and width are initialized as a function of the global shape of the absorptions present. The values of characteristic parameters of each gaussian are estimated based on [7,8].

As we deal with rocks whose mineralogy is assumed to be unknown, we have developed the following procedure when implementing the MGM approach. We use different numbers of gaussians, depending on the complexity of the mixture, i.e. two gaussians for simple pyroxene composition up to seven gaussians for an olivine/HCP/LCP mixture. We run the MGM modelling for all the mixture possibilities involving the three mafic components. The identification of minerals is carried out through a systematic search using laboratory data for pyroxene mixtures and members of the olivine solid-solution [2,7,8]. Comparison with these laboratory based band parameters (center, strength, width) is used to assess which deconvolutions are most appropriate from a spectroscopic viewpoint [5,6].

Implementation: This procedure has been applied on different spectra from RELAB of SNC meteorites as shown in Fig. 1. The first spectrum (Fig. 1.a), corresponds to ALH84001. Based on the band positions in the 1µm and 2µm domains, centred at 920 and 1945 nm respectively, MGM deconvolution indicates that it is a low calcium pyroxene (LCP), identified as an orthopyroxene in agreement with observed mineralogy [9,10,11]**.** Figure 1.b displays the deconvolution for the spectrum of ALH77005-B and detects the presence of both orthopyroxene and olivine, consistent with a harzburgitic composition. Though not shown here, spectra ALH77005-C and ALH77005-D have also been analyzed and show variations, with spectrum C corresponding to a low-calcium pigeonite and spectrum D, being consistent with a more olivine-rich opx-ol assemblage. A third spectrum, corresponding to Chassigny meteorite, is shown on Fig. 1.c. MGM deconvolution conspicuously detects olivine. Absorption bands are prominent and the centre positions identify a magnesium-rich forsterite type, in agreement with the observed dunitic petrology [e.g.,12]**.** The last three graphs (Figs. 1.d, 1.e, 1.f) display the results produced on two spectra, referred to as A-73 and B-PB, representative of lithologies A and B of meteorite EET79001. MGM deconvolution returns two possibilities for spectrum A-73, consistent with either an augitic composition (Fig. 1.d) or with a two-pyroxene assemblage (Fig. 1.e) consistent with complex zoning of the pyroxenes in lithology A. For B-PB spectrum, Fig. 1.f shows that clinopyroxene is identified, with absorption characteristics indicative of an augitic composition. However, another solution not shown here is also returned, involving a two-pyroxene assemblage, in agreement with [4, 11]. Overall, our results confirm the view that EET79001 is a complex case, with heterogeneous phases [13]**.** Deconvolution of Shergotty and Zagami meteorite spectra also present results close to EET79001B-PB, consistent with an augitic composition or a two-pyroxene assemblage.

Conclusion: The present systematic analysis of SNC reflectance spectra leads to reliable detection of complex mafic lithologies based on the band positions in the 1µm and 2µm domains. Both the implemented methodology and the scientific outputs are of interest for interpreting the spectra acquired for the Martian surface by Omega / MEX or CRISM/ MRO, and improving our knowledge of Mars petrology [e.g.,14,15].

References: [1] Burns (1993), *Cambridge Univ. Press, NY*. [2] Adams (1974), *JGR 79*,4829-4836. [3] Sunshine J.M. et al. (1990), *JGR, 95*, 6955. [4] Parente, M. and Bishop, J.L. (2006), LPSC 37th, # 1535. [5] Pinet, P.C. et al. (2006),

LPSC37th, #1346; Pinet, P.C et al. (2007), Mars Conf 7th, Pasadena, #3146. [6] Clenet, H. et al. (2008), LPSC 39th, Houston, # 1918. [7] Sunshine J.M. et al. (1993), *JGR, 98*, 9075. [8] Sunshine J.M. et al. (1998), *JGR, 103, E6*, 13675. [9] Kanner L. et al. (2007), *Icarus,* 187, 442-456. [10] Cloutis, E.A., Gaffey, M.J. (1991), *JGR*, 96, 22,809-826. [11] Sunshine, J.M. et al. (1993), *Icarus*, 105, 79-91. [12] Floran R.J. et al. (1978), *GCA*, *42*, 1213-1229. [13] McSween H.Y. (1994), *Meteor. & Planet. Science*, 29,757-779; Mars meteorite compendium 2003, section IX. [14] Poulet F. et al. (2007), *JGR*, 112, E08S02, 1-15. [15] Poulet, F. et al. , *Icarus, in press*.

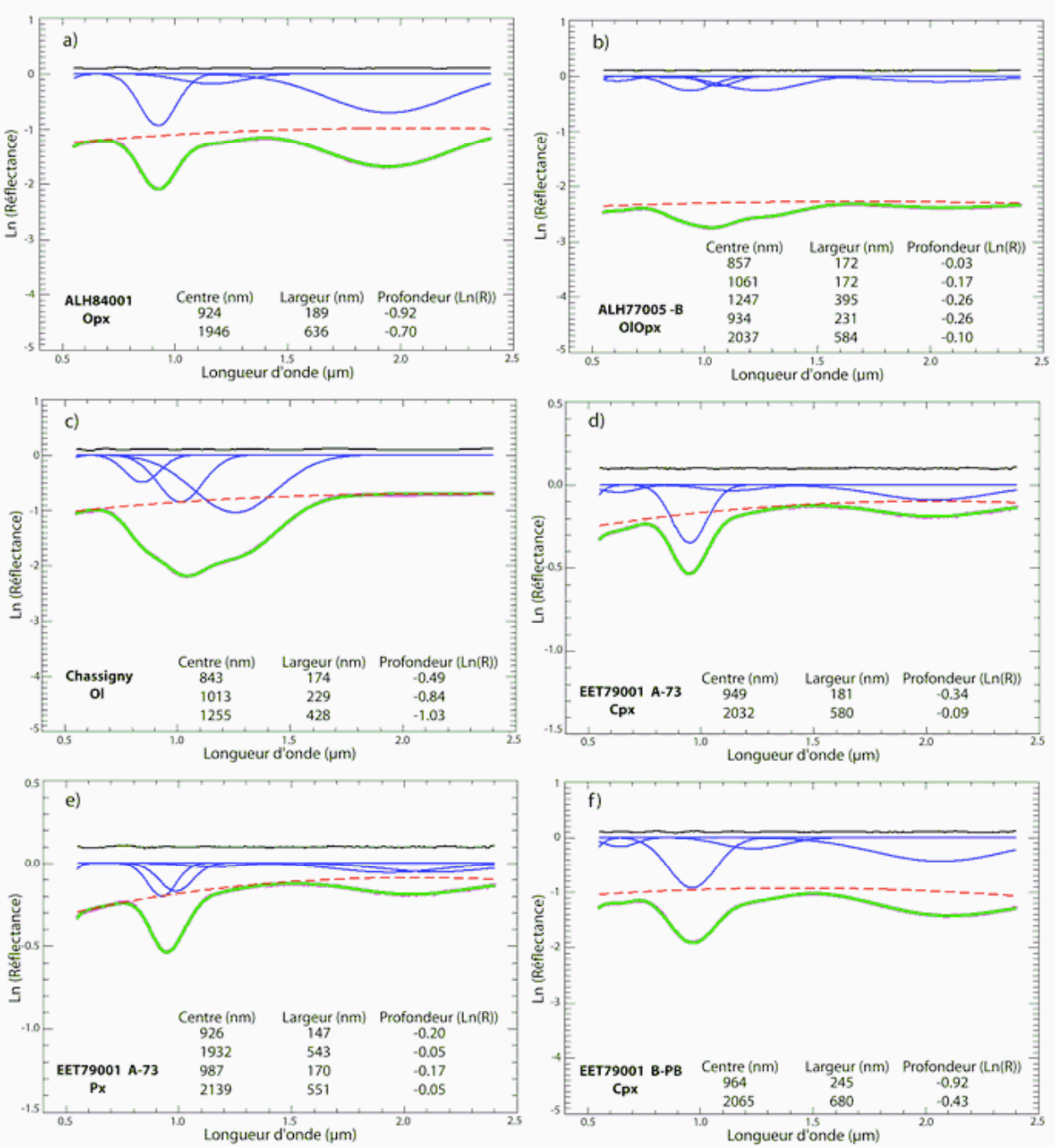

Figure 1. MGM deconvolutions of SNC reflectance spectra from Relab. Each graph corresponds to a given meteorite, with its associated MGM configuration(s): **a.** Orthopyroxenite (ALH84001), **b.** Harzburgite (ALH77005) , **c.**. Dunite (Chassigny), **d.** and **e**. Clinopyroxenite (EET79001 A-73), and **f.** Clinopyroxenite (EET79001 B-PB). (Note: "Longueur d'onde" means wavelength;" Largeur" means width; "Profondeur" means depth).