EVIDENCE FOR ANALOGUE MINERALOGICAL SITE AT MARS TO THE LOS ANGELES BASALTIC SHERGOTTITE.

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Introduction: Martian meteorites provide important compositional information about crustal rocks and could enable ground truthing of orbital data. Conversely, locating one or more regions with composition similar to that of Martian meteorites would provide key information on the Martian crust and mantle, through the extensive laboratory investigations on these meteorites. In addition, it would enable an absolute age calibration of major Mars events. Our objective is thus to identify, map, and characterize possible analogue source regions for the SNC martian meteorites using data from the hyperspectral near-infrared imager MEx/OMEGA. OMEGA provided a nearly complete coverage of the Martian surface, which can be used to characterize the surface mineralogy, down to a sub-kilometer scale. The study presented here focuses on the basaltic shergottite Los Angeles, which is composed of about 45% of plagioclase (maskelynite), 43% of pyroxene (pigeonite and augite), 2-5% of olivine (fayalite) and other minor constituents (silica, oxydes, glass,etc..) [1]. This study is the first step of a systematic work, whose aim is to identify and map the possible sources for all martian meteorites using the OMEGA dataset.

Observations and methodology: Our analysis is based on the complete OMEGA dataset using the C channel (1.0 –2.5 µm) acquired since 2004, which corresponds to more than 3 martian years of observation, 8534 orbites, 8113 cubes and more than 440 million of spectra. Since the spectrum of the basaltic shergottite Los Angeles (*RELAB ID MT-JFM-005*, [2]) exhibits significant signatures of pyroxene at 1 and 2 µm, we restricted the search to OMEGA spectra showing a pyroxene signature estimated by a pyroxene spectral parameter developed in [3]. OMEGA observations disturbed by surface frost or ices and atmospheric effects (clouds, aerosols) have also been removed from the dataset thanks to a filtering process based on parameters that gauge the presence of H2O, CO2 ice and dust opacity [4]. Every OMEGA spectrum is compared to the Los Angeles spectrum by varying both its continuum and its slope in order to take into account the spectral effects of aerosol, dust coverage, spatial mixture and photometry. The fitting function is hence:

F = LA_spectrum + A + B* LA_wavelengths

where LA_spectrum is the shergottite basaltic Los Angeles spectrum, LA_wavelengths the associated wavelengths, A the continuum offset and B the adding slope coefficient. The quality of the fit is evaluated as a calculated between 1 and 2.5 µm for each OMEGA pixel. A χ^2 global map with a grid of 40 pixels per degree is made by selecting the lowest value of for each pixel if there is an overlap.

Results: The χ^2 global map is shown in Figure 1. The fit is considered as satisfactory for χ^2 values lower than 0.002. χ^2 values larger than 0.008 are mapped in blue so as to illustrate the global coverage with the restricted OMEGA dataset. The lowest χ^2 values are mainly found between 0° and 30°S in pyroxene- and olivine-bearing terrains of various regions: Valles Marineris, Terra Meridiani, Terra Sabea, Tyrrhena Terra, Terra Cimmeria, Hesperia Planum and Terra Sirenum. Figure 2 shows an example of geological context in the region of Tyrrhena Terra where the lowest χ^2 values are associated to smooth plains (figure 2E). These smooth plains are olivine- and pyroxene-bearing and are early Hesperian in age. Two OMEGA spectra extracted from both low and high χ^2 values regions (yellow stars) are shown in Figure 2D. The associated fitted Los Angeles spectrum is plotted in red for comparison. The low value OMEGA spectrum with the lowest χ^2 has a large 1 µm band depth and a shift of the pyroxene spectral features toward longer wavelengths, which are attributed to the presence of olivine. Low χ^2 values are also obtained found in pyroxene/olivine-bearing sands/dunes in smooth crater floors of early Hesperian age. In Valles Marineris, we have identified with a high level of confidence large areas with low values of χ^2 in its walls and in sands located in depressions.

The age of SNCs is still under debate. For instance, the age of Los Angeles is estimated to be 165±11 Ma by [5] and 4050±70 Ma by [6]. This study shows that the Martian meteorite Los Angeles is spectrally similar to early Hesperian magma that has filled craters and inter-craters plains throughout the southern highlands, which is clearly more consistent with the age of 4 By.

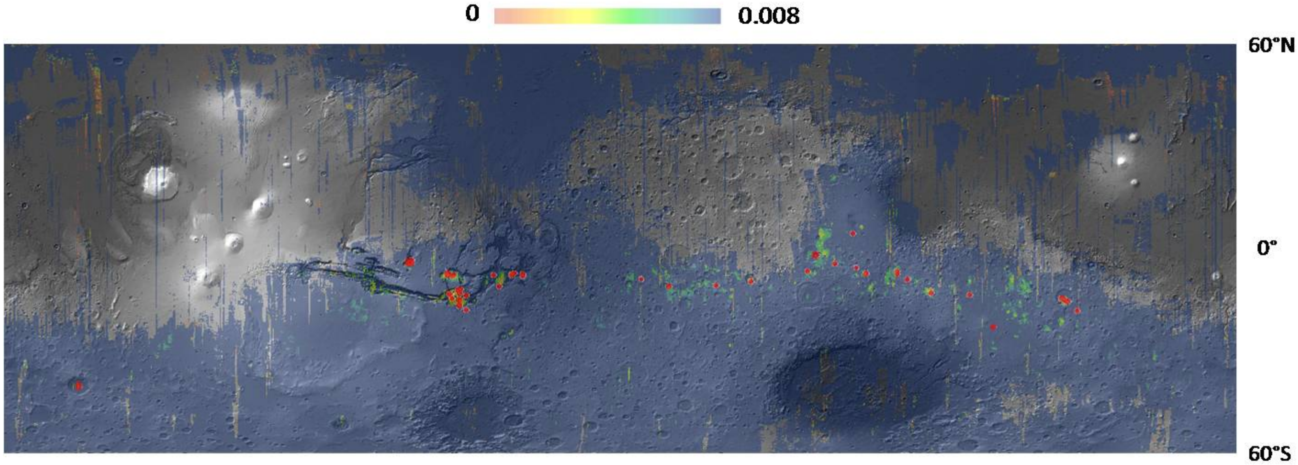

Figure 1. *The 40 pixels per degree χ^2 global map over MOLA global map. Red circles correspond to χ^2 values smaller than 0.002, which can be considered as satisfactory fits.*

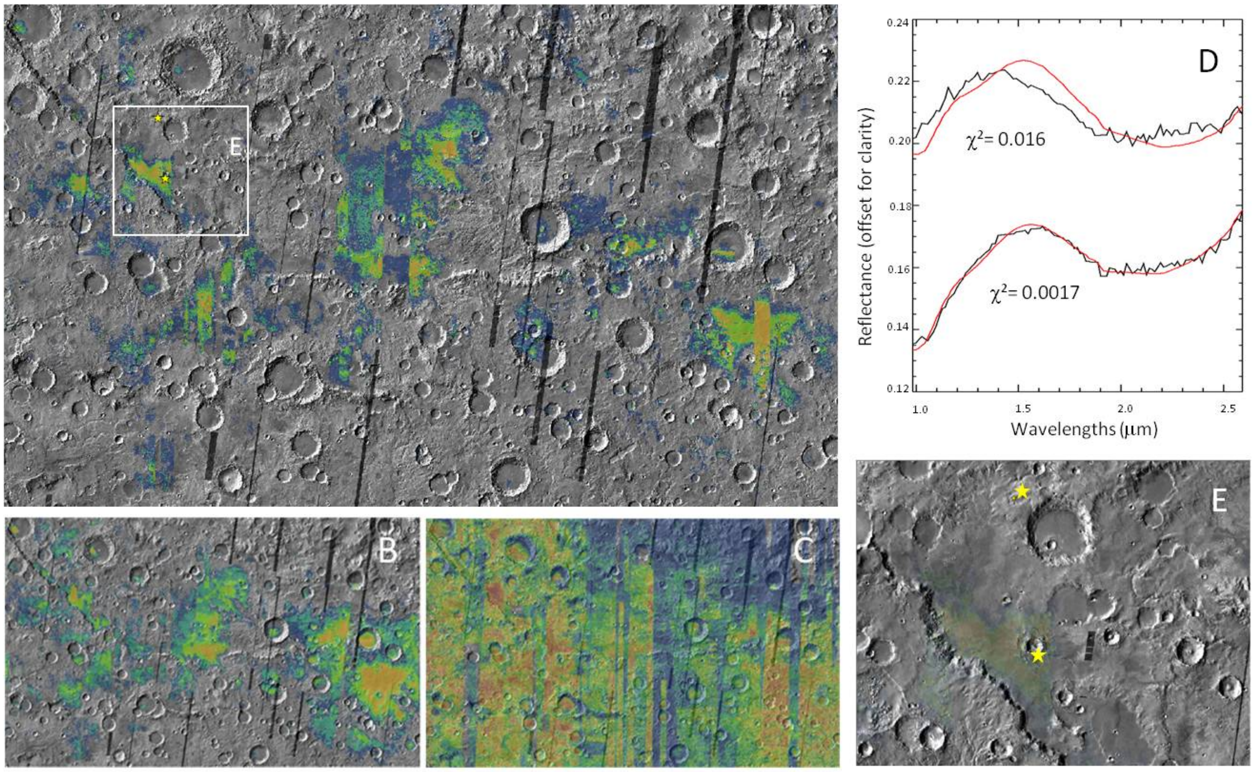

Figure 2. *(A) χ^2 map in the region of Tyrrhena Terra over the THEMIS daytime mosaic (same color scale as figure 1). Olivine map (B) and pyroxene map (C) of the same region derived from spectral parameters described in [4]. The spectral parameters values are plotted from the blue to the red for values ranging from 1.0 to 1.06 for olivine and 0.025 to 0.055 for pyroxene. (D) OMEGA spectra (black curve) extracted from the regions indicated by yellow stars on (A) and compared to their respective best fit derived from the Los Angeles spectrum (red curve).(E) Zoom of one of the low χ^2 values smooth plains (white square on (A))*

References: [1]Warren et al. (2003) Meteoritics & Planetary Sciences 39,Nr 1, 137-156. [2] Mc Fadden and cline (2005) M Meteoritics & Planetary Sciences 40, Nr 2, 151-172. [3] Poulet et al. (2007) JGR vol.112, E08S02. [4] Ody et al. (2010) LPSCXXXXI. [5] Nyquist and Reese (2000) Meteoritics & Planetary Sciences 35. [6] Bouvier et al. (2007) Earth and Planetary Science Letters 266,105-124.