CHONDRITES ANALYSIS BY RAMAN AND INFRARED SPECTROSCROPY PREPARING SUPERCAM

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Introduction: The Martian rovers Opportunity [1-3], Spirit [1] and Curiosity [2] have detected a total of 20 iron and stony-iron meteorites. On Earth, for 3 iron meteorites, there are 52 ordinary chondrites and 3 carbonaceous chondrites meteorites falls. With a chemical weathering of 1-4 orders of magnitude slower than on Earth [4] and older stable surfaces, Mars probably has a meteorites accumulation of $2x10^2$-$2x10^5$ meteorite/km^2 [5]. With those statistics, SuperCam should come across stony meteorites. The study of chondrites on Mars can give crucial information on the past and present atmosphere, and the contribution of exogenic material [4]. Through analyzing the mineralogy by two channels of observation on SuperCam, the Raman spectrometry and the VISIR reflectance spectroscopy, we can define how to detect chondrites and make the distinction between the diverse classes and groups.

Methodology: SuperCam will perform the mineralogy analysis on Mars using the Raman and the VISIR reflectance spectroscopy [6]. These allow a "bulk" analysis of the mineralogy as the spot of the analysis is greater than the largest constituents of the meteorites. The VISIR reflectance spectroscopy was made at the IPAG in Grenoble France. The spectral range extends from 0.4 to 2.6 µm with a spot of analysis around 7mm. The Raman analyses were conducted at IMPMC in Paris and LGLTPE in Lyon, using respectively pulsed and continuous Raman spectrometry. The pulsed laser works with a 532 nm wavelength at a distance of 8m with a spot of analysis of 7-8mm of diameter.

Samples: 5 ordinary chondrites (H, L, LL), 4 carbonaceous chondrites (CV, CM, CR, CK) and 1 enstatite chondrite (EH) were considered. Those spanned the most common types of chondrites, which could be the most likely observable chondrites on Mars. The analyses were made on the raw samples without any preparations, to reproduce the natural conditions of *in situ* rock analysis on Mars. Some samples were simply sawn, to expose fresh material, and two of them presented a fusion crust which was also analyzed.

Results: The Raman spectrometry and the IR reflectance spectroscopy allow a distinction between the three classes of chondrites. The ordinary chondrites spectra show olivine and pyroxene in different proportions. The carbonaceous chondrites present a high background in Raman spectrometry, with weak olivine peaks on both Raman spectrometry and VISIR spectroscopy (*Fig. 1)*. Finally, enstatite chondrites show only pyroxenes peaks. The ordinary chondrite class displays significant variations in olivine and pyroxenes proportions, with the pyroxene proportions decreasing from the H to the LL groups, thus enabling their differentiation. The carbonaceous chondrites spectra are too noisy to enable the distinction of the different groups at this point. Only one sample of enstatite chondrite was analyzed.

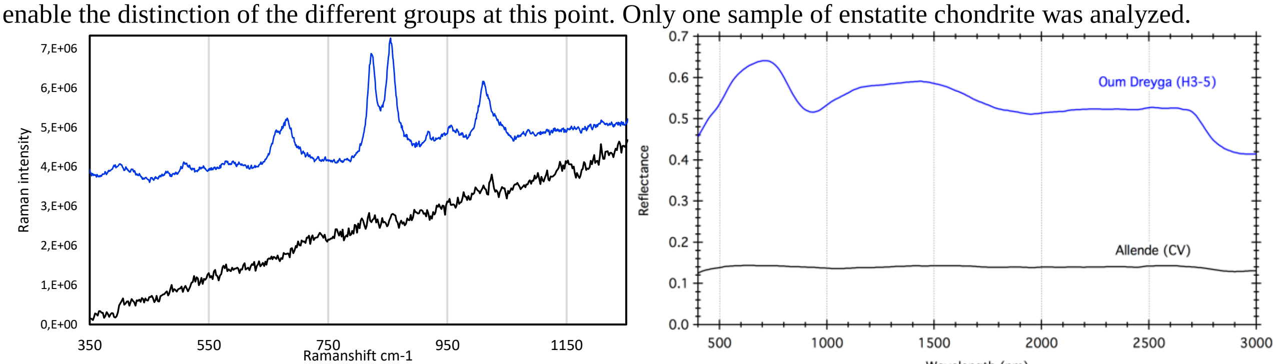

Figure 1: Raman spectra (Left) and IR spectra (Right) of ordinary chondrite Oum Dreyga (blue) and carbonaceous chondrite Allende (black).

Discussion: The distinction of the meteorite classes can be made by both Raman and VISIR instruments. The different groups of ordinary chondrites can be differentiated by their different ratios of olivine and pyroxene. The detection of meteorites in the Martian geological environment needs to be further studied, as chondrites will be easier to detect in surroundings presenting a different background mineralogy. Moreover, most of the meteorites found on Mars to this date are iron meteorites. The missing chondrites have many possible explanations, like a faster alteration of chondrites, weaker resistance to impact [7], or a sampling bias because of the ease to spot iron meteorites.

References:

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