EPSC Abstracts
Vol. 6, EPSC-DPS2011-902, 2011
EPSC-DPS Joint Meeting 2011

Analyses of a few fragments from the Paris meteorite through SEM/EDX, µ-FTIR and µ-Raman spectroscopies

S. Merouane (1), Z. Djouadi (1), R. Brunetto (1), J. Borg (1) and P. Dumas (2)
(1) IAS, UMR8617, Orsay, France, (2) Synchrotron SOLEIL, Saint-Aubin, France (sihane.merouane@ias.u-psud.fr)

Abstract

We analyzed a few fragments from the Paris meteorite through µ-FTIR, µ-Raman spectroscopies and SEM/EDX analyses in order to get information on their mineralogical, organic and elementary composition. We show that these grains have suffered a significant aqueous alteration and a weak thermal metamorphism. Their mineralogical, organic and elementary properties classify them close to the CI or CM meteorite-type.

1. Introduction

The Paris meteorite is a carbonaceous chondrite which was acquired by the French Museum National d'Histoire Naturelle (MNHN, Paris). The carbonaceous chondrites, the composition of which is close to the Sun's, are considered to be the most primitive objects of the Solar System. Thus, the laboratory study of these samples enables us to investigate the different processes the meteorites – and thus, their parent bodies – have suffered and therefore, get clues on the formation and evolution of the Solar System.

In order to have insights into Paris' characterization, we use infrared (IR) and Raman spectroscopies, which give information on the chemical bounds in the sample, and consequently, on its composition (both in minerals and organics) but also on its amorphous/crystalline structure. Thanks to synchrotron radiation, we are able to characterize heterogeneities at a micrometer scale (>5µm). Raman spectroscopy allows a more precise characterization as we can reach spatial resolutions of about 1 µm. SEM/EDX analyses complete these informations by giving the elemental composition of the samples at the same spatial resolution.

2. Experiment

A few fragments from the 13 mg received from the MNHN were crushed in a diamond compression cell following [2]. Mid and Far infrared (IR) spectra (2.5 to 100 µm, or 4000 to 100 cm^{-1}) were acquired on the SMIS2 beamline of the SOLEIL Synchrotron (France) using a NicPlan microscope attached to a Fourier Transform infrared spectrometer (FTIR). Raman spectra were acquired at SOLEIL with a spectrometer DXR from Thermo Fisher with a 532 nm laser and SEM-EDX analyses were performed with a SEM Hitachi 3600N and an EDX spectrometer ThermoNoran System SIX at the Institut d'Electronique Fondamentale (Orsay, France).

3. Mineralogical composition

IR spectra reveal that the analyzed samples are dominated by crystalline phyllosilicates and carbonates (Figure 1) implying a significant aqueous alteration. Raman spectra are dominated in the mineral region by magnetite but also show the presence of calcite and traces of iron sulfides. Anhydrous silicates (forsterite and iron-rich pyroxene) were found as small inclusions using both IR and Raman spectroscopies.

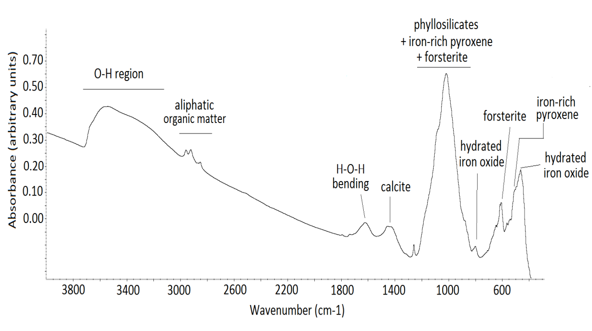

Figure 1: Absorption infrared spectra of a 90 µm-diameter fragment of Paris.

IR maps have been acquired with a spatial resolution of 8 µm x 8 µm in order to study the distribution of the different components into the grains, thus we could show that carbonates are localized in specific regions.

4. Organic matter

We measure a CH_2/CH_3 ratio (obtained from Mid-IR spectroscopy) of 2.3 ± 0.2, which is in good agreement with the values of the CM meteorite Murchison and the CI Orgueil [4]. The study of aromatic carbon is given by the so-called D and G bands, which are sensitive to thermal alteration [3]. They indicate here that the fragments we analyzed experienced a weak thermal metamorphism, as shown in Figure 2.

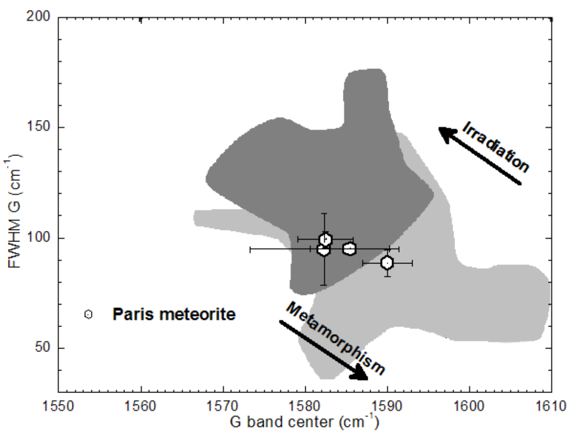

Figure 2: Width of the G band against its position in different regions of the analyzed Paris grains. Characteristic regions for IDPs (dark grey area) and meteorites (light grey area) are represented [5].

5. Elementary composition

Elementary ratios were determined through SEM/EDX. They are in good agreement with CI and CM chondrites [1], [6] except for Ca, and, to a lesser extent for Ni, which are more abundant in the Paris grains we analyzed. Ca is more than 4 times more abundant than what is given for CI and CM meteorites. This excess could be due to a bias in the selection of the fragments, or a characteristic of this meteorite, in which case, more investigation has to be performed. A comparison of the distribution of carbonates (obtained in µ-FTIR) with the distribution of Ca (obtained with SEM/EDX) reveals that most of the Ca is incorporated into the carbonates.

6. Summary and Conclusions

The characteristics of the mineralogical and organic components present in the few fragments of Paris studied are in agreement with the CI and CM chondrites. The presence of abundant phyllosilicates and carbonates implies that these grains have suffered a significant aqueous alteration and their aromatic components exhibit features characteristic of a weak thermal alteration.

References

[1] Anders, E., Grevesse, N.: Abundances of the elements: Meteoritic and solar, Geochemica et Cosmochemica Acta, Vol. 53, pp. 197-214, 1989.

[2] Brunetto, R. et al.: Mid-IR, Far-IR, Raman micro-spectroscopy, and FESEM-EDX study of IDP L2021C5: Clues to its origin, Icarus, Vol. 212, pp. 896-910, 2011.

[3] Busemann, H. et al.: Characterization of insoluble organic matter in primitive meteorites by microRaman spectroscopy, Meteoritics & Planetary Science, Vol. 42, pp. 1387-1416, 2007.

[4] Matrajt, G. et al.: FTIR analysis of the organics in IDPs: Comparison with the IR spectra of the diffuse interstellar medium, Astrnomy&Astrophysics, Vol. 433, pp. 979-995, 2004.

[5] Rotundi A. et al.: Combined micro-Raman, micro-infrared, and field emission scanning electron microscope analyses of comet 81P/Wild 2 particles collected bu Stardust, Vol 43, pp. 367-397, 2008.

[6] Sears, D.W.G., Dodd, R.T.: Meteorites and the early Solar System, chapter 1: Overview and classification of meteorites, The University of Arizona Press, pp. 3-31, 1988.