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Chemical functional characterization of coals and extraterrestrial materials using infrared spectroscopy: *from bulk toward to nanoscale.*

VAN THI HAI PHAN[1], ROLANDO REBOIS[1], PIERRE BECK[1], ERIC QUIRICO[2], TAKAAKI NOGUCHI[3] AND MINAKO TAKASE[3]

[1]Institut de Planétologie et d'Astrophysique de Grenoble (IPAG)
[2]Institut de Planétologie et d'Astrophysique de Grenoble
[3]Kyushu University

Presenting Author: thi-hai-van.phan@univ-grenoble-alpes.fr

Asteroids, fragments be found on earth as meteorites, can be contained different compositions of organic matters (OM), silicates, sulfides, carbonates and water ice [1]. To understand how and under which conditions OM has interacted with inorganic phases is a key step hypothesis on the mechanism of the accreted OM. Nano-IR spectroscopy can provide a spatial resolution beyond the diffraction limits [2], [3] could be suitable technique to analyse OM without losing the petrographical information and efficiently unmixed spectral signatures of the different constituents. We apply here a NanoIR3s (IPAG) to characterise a suite of coals samples as analogues, meteorites as well as their extracted Insoluble Organic Matter (IOM).

The results show in Fig. 1 indicating the IR maps of OM (1720, 1600 and 1450 cm^{-1}) and phyllosilicate (1040 cm^{-1}) on the coal sample and confirming the actual spatial resolution of 18 nm. Fig. 2 provides a composition image obtained from the three maps, colour coded according to C=O (1700 cm^{-1}, in blue) C=C (1600 cm^{-1} in red) and Si-O vibrations (1040 cm^{-1} in green). Two major types of spectra are present in the sample, these spectra dominated by a strong band at about 1040 cm^{-1} (phyllosilicate) and at 1700, 1600, 1450 cm^{-1} (complex OM). These results reveal the capability to obtain the unmixed spectral signature of inorganic and organic species and gives insights into the spatial resolution of the techniques.

We will present at the conference the whole dataset obtained so far, including a comparison of organic signatures of IOM and raw meteorite matrix, and discuss our plan.

References: [1] Alexander et al. (2007). *Geochimica et Cosmochimica Acta*, *71*, 4380–4403. [2] Kebukawa et al. (2018). *PNAS*, 1–6. [3] Mathurin et al. (2019). *Astronomy & Astrophysics*, *160*, 1–9.

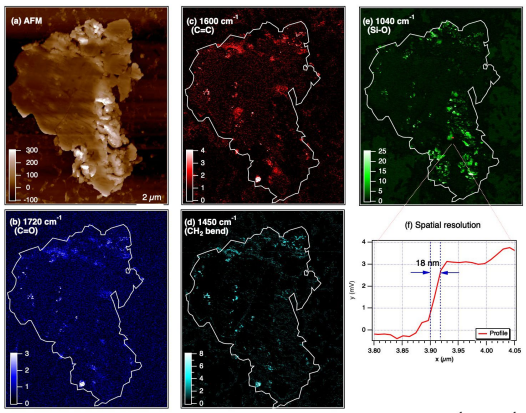

Fig. 1. Colour maps showing the measured intensity maps of coal from (a) AFM image, the band at (b) 1700 cm^{-1} (c) 1600 cm^{-1} d) at 1040 cm^{-1}, (e) 1450 cm^{-1} and (f) the spatial resolution.

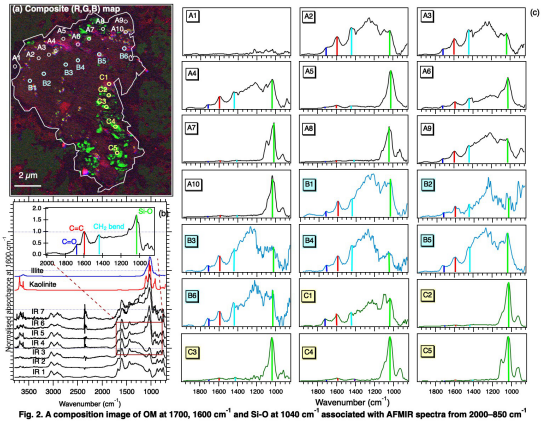

Fig. 2. A composition image of OM at 1700, 1600 cm^{-1} and Si-O at 1040 cm^{-1} associated with AFMIR spectra from 2000–850 cm^{-1}