

---

# UV luminescence characterisation of organics in Mars-analogue substrates.

Boris Laurent<sup>\*1,2</sup>, Claire Cousins<sup>1</sup>, Matt Gunn<sup>2</sup>, Carys Huntly<sup>2</sup>, Rachel Cross<sup>2</sup>, and Elyse Allender<sup>1</sup>

<sup>1</sup>School of Earth and Environmental Sciences, University of St Andrews – St Andrews, Scotland, United Kingdom

<sup>2</sup>Institute of Mathematics, Physics and Computer Science, Aberystwyth University – Aberystwyth, Wales, United Kingdom

## Abstract

### 1. Introduction

Delivery of exogenic organic matter is a daily process on Mars, up to  $4 \times 10^{-4}$  g. m<sup>-2</sup>. yr<sup>-1</sup> [1]. A fraction of this matter comprises PAHs, that are both ubiquitous in space and of astrobiological interest [2, 3]. The study of the fate of PAHs is the first step towards the detection of organic matter and putative organic biosignatures in situ on the martian surface. Detection of simple and complex organic signatures are often hampered or modified by interaction with the host geological substrate. In that respect, UV excited Photoluminescence imaging offers a contactless, non-destructive and, through the addition of imaging, spatially resolved tool. Compared to Raman, UV luminescence is several orders of magnitude more sensitive than Raman [4], while Raman provides more detailed structural information. Recently, the Scanning Habitable Environments with Raman & Luminescence for Organics & Chemicals ("SHERLOC") instrument was selected as part of the payload for the NASA Mars 2020 Rover mission. This instrument is a deep UV ( $\lambda_{\text{ex}}=248.6$  nm) Raman and Luminescence imaging spectrometer [5], and will be the first dedicated spectrometer with UV capability to be deployed at the Martian surface.

### 2. Methods and samples

Three Mars analogue sediments from Iceland were selected to represent the three broad mineral epochs of Mars: Mudstone (phyllosilicate), Gypsum (sulfate) and a Fe-oxyhydroxide "Oxide" sediment (iron oxide). These were spiked with either anthracene or pyrene (15 ppm, Sigma Aldrich PAHs solutions) and then pressed into pellets. Synthetic epsomite and halite crystals were prepared from MgSO<sub>4</sub>·7H<sub>2</sub>O, and NaCl saturated solutions, including solutions spiked with either anthracene or Perylene (2 ppm), and solutions additionally spiked with iron oxide (hematite, 1 w. t%). Finally, three CM chondrites were analysed, including the Meteorite Hills MET01072 meteorite (CM 2.3) and the Alan Hills meteorite ALH84044 (CM2, 1.045 g), loaned from NASA JSC, USA, and Murchison (CM2.5) loaned from the Natural History Museum, UK. A kerogen type IV sample was also included. UV luminescence

---

\*Speaker

analyses were performed both at room temperature, and at low temperature (30K) using the Hyperspectral Luminescence and Optical Spectroscopy (HeLIOS, Cross et al. 2013), with a number of excitation wavelengths ( $\lambda_{\text{ex}}$ ) ranging from 225 – 375 nm.

### 3. Results and Discussion

**Sediments**-Differences in actual luminescence response are visible for Gypsum at  $\lambda_{\text{ex}} = 280$  nm, in the addition of perylene and anthracene, resulting in an increased luminescence at  $\sim 420$  and 500 nm. When spiked with PAHs, the Mudstone luminescence response shows only minimal changes with  $\lambda_{\text{ex}} = 280$  nm excitation at  $\sim 420$  nm and 580 nm. PAHs on the Oxide matrix have little to no effect. Thus, as previously observed for pure PAHs [6], the maximum wavelength intensity for 2-5 rings PAHs is located at  $\sim 420$  nm. **Salts**-The addition of PAHs influences the luminescence response only at  $\lambda_{\text{ex}} = 365$  nm. For all the samples, under  $\lambda_{\text{ex}} = 365$  nm the addition of iron oxide also quenches the luminescence response, with an additional red emission peak at 720 nm. **Chondrites**-All meteorites and the Type IV kerogen exhibit a strong blue photoluminescence emission between 450 – 490 nm and an additional red emission luminescence peak centred at  $\sim 720$  nm, with a stronger response for CMs that have endured less thermal metamorphism. This is possibly the result of a higher maturity concentrating the chromophores (C=C and C=O bonds) and thus absorbs most of the luminescence [7]. For Murchison and kerogen samples, the emission spectra become more resolved as excitation wavelength increases, as the number of resolvable peaks increases from 2 – 3 at the two shortest excitation wavelengths, to 5 resolvable peaks at the two longest excitation wavelengths.

### 4. Acknowledgements

The authors thank the NHM London (Caroline Smith, Natasha Almeda) for the Murchison loan (MIN2017- 674MET) and the NASA JSC ARES division (Kevin Righter) for the Antarctic meteorites (ID: person-924), as well as Zita Martins for her help for the meteorites acquisition. This work is funded by The Leverhulme Trust (RPG-2015-071).

### 5. References

Flynn, G. J., and D. S. McKay (1990) *J. Geophys. Res.*, 95(B9), 14497–14509. [2] Ehrenfreund et al. (2011) *International Journal of Astrobiology*, 10(3), 239-253. [3] ten Kate, I. L. (2010), *Astrobiology* 10(6), 589–603. [4] Dartnell, L. R. et al. (2012). *Meteorit. Planet. Sci* 47(5), 806-819. [5] Beegle et al. (2014) 11th International GeoRaman Conference. [6] Eshelman et al. (2018) *Planet. Space Sci.*, 151, 1-10. [7] Bertrand et al. (1986) *Org. Geochem.*, 10(1-3), 641-647.