CO-ORDINATED UV REFLECTANCE AND RAMAN SPECTROSCOPY OF MARTIAN METEORITES AND TERRESTRIAL ANALOGUE SAMPLES

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Introduction: Reflectance spectroscopy acquired by orbiting spacecraft over a range of wavelengths is a common tool used to determine the mineralogy of planetary surfaces. Hydrous and anhydrous silicate minerals, sulphides, sulphates and carbonates have prominent features in the Vis-NIR ($\lambda \sim 300 - 2100$ nm). Organic species are detectable at lower wavelengths, $\lambda \sim 180 - 300$ nm. Raman spectroscopy is a method employed to identify minerals and organic species *in situ* and will be part of the instrument suites carried by the Mars 2020 and ExoMars 2020 rovers for analysis of surface materials.

Aim: to investigate mineral-organic relationships in martian meteorites by UV-Vis microspectrophotometry (MSP) and Raman spectroscopy. Our intention is to produce spatial distributions of organic species on broken surfaces of martian meteorites and terrestrial analogues, providing a series of measurements to assist in interpretation of data acquired on Mars. That would then help in identifying suitable (potentially organic-rich) rocks for acquisition and caching. The project has synergies with the investigations that the Sherloc instrument will carry out on the surface of Mars

Method: Diffuse reflectance spectra of a series of minerals, powdered organic compounds and martian meteorites were obtained using a CRAIC UV-Vis MSP fitted with 3 Cassegrain objective lenses. The system has two lamps, deuterium and xenon, that operate in parallel, resulting in a useful spectral range of 200 – 900 nm. The lamp output is delivered to the microscope by fibre-optic, resulting in a focusable area of 2 x 2 µm to 10 x 10 µm, depending on the combination of mirrors selected. Incidence and exit angles are perpendicular to sample. Raman spectra were obtained using a Jobin Yvon Labram HR laser Raman microprobe equipped with 3 lasers (514 nm Ar ion, 632 nm HeNe and a 785 nm diode); separate spectra were taken using each of the three lasers. Material (usually < 5 mg) broken from chips of martian meteorites and terrestrial basalts from Iceland, Norway and Canada were coarsely crushed (grain-size < 200 µm) and placed on quartz-glass slides for UV-Vis then Raman analysis.

Results: UV-Vis spectra (240 – 400 nm) from broken surfaces of inorganic minerals relevant to the composition of Mars' surface and from the Chassigny, Nakhla, Shergotty and Zagami martian meteorites are shown in the figures below. The marked weak features at 257 nm and 280 nm are possibly from electronic transitions, whilst the stronger features in the meteorites at 320 nm and 345 nm may be from organic functional groups. Raman analysis will assist in absolute identification of these features. The next stage of the project is to re-analyse the specimens after they have been mixed with (a) individual organic molecules and (b) combinations of molecules, with the aim of determining the minimum concentration of organics detectable, both in UV-Vis and Raman spectra.

Summary: UV-Vis microspectrophotometry complemented by Raman spectroscopy is a potential tool for rapid, non-invasive and non-destructive laboratory analysis of planetary samples. Comparison with spectra from organic and inorganic species should allow elucidation of interactions between organics and mineral matrices, and assist in interpretation of data from the surface of Mars.