MARTIAN METEORITES THROUGH THE EYES OF THE EXOMARS ROVER: PREPARING FOR PANCAM ON MARS

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1. INTRODUCTION

The ExoMars Rosalind Franklin rover is scheduled to be launched in summer 2022 with a suite of instruments to investigate the Martian surface and near sub-surface [1]. The context instruments: the Panoramic Camera (PanCam), composed of the two Wide Angle Cameras (WACs), and High Resolution Camera (HRC), and the Infrared Spectrometer for ExoMars (ISEM) will be imperative in the selection of drill and analysis sites.

The PanCam stereo imaging system will be the primary mode of scientific observation during the mission with two multispectral WACs in the Visible to Near Infrared (VNIR, 440-1000 nm) range mounted at the top of the 2 meter mast [2]. Within the 36° field of view of the WACs, HRC will provide 5° field of view colour images at up to submillimetre resolutions [2]. Lastly, ISEM can them be utilised within the WAC/HRC field of views to provide 1° spot size, hyperspectral coverage in the Near to Mid (1150-3300 nm) Infrared range [3].

In preparation for the mission, spectral analysis tools are being developed to automate as much of the analysis process, as is feasible, to reduce time and effort costs during mission tactical planning and analysis, as well as improving ability to discriminate between different minerals of interest. In particular Spectral parameter mapping will be developed based on features identified from this studdy for use duing mission timescales This study utilises Martian meteorite samples as a method of developing and testing these tools.

2.Instrumentation

The Aberystwwyth PanCam Emulator (AUPE) was utilised to provide multispectral PanCam WAC images (12 bands in the VNIR) with spatial resolution of 1.3mm per pixel at 2m, of a number of meteorite samples. Onboard AUPE the HRC emulator was used to capture high-res colour images, ~0.17mm per pixel at 2m. To gain a quantitative comparison of the ExoMars instruments a VNIR hyperspectral camera and VNIR point spectrometer were used to acquire hyperspectral counterparts of the PanCam data.

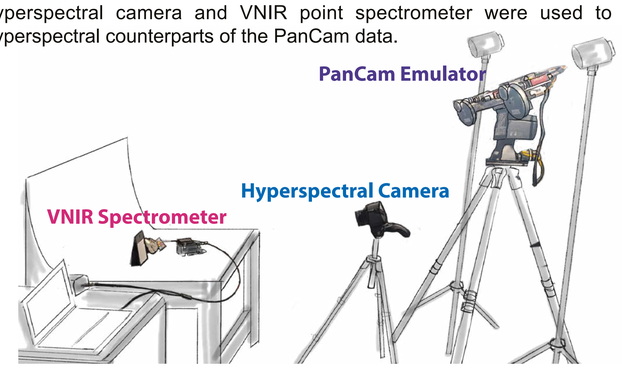


Figure 1. Experimental set up with relative positioning of PanCam emulator (AUPE), Hyperspectral Camera and VNIR Spectrometer.

3.Experimental Set Up

Martian meteorite samples were imaged in a photo studio dark room under constant tungster illumination. Data was first taken with PanCam, and HRC, (set at 1.8m high and 1.8m from the sample plane at minimal operational distance to accomodate the LWAC/RWAC image cross over for stereo imaging), the hyperspectral camera in two configurations and lastly the point spectrometer targetting regions of visual interest, shown in figure 2.

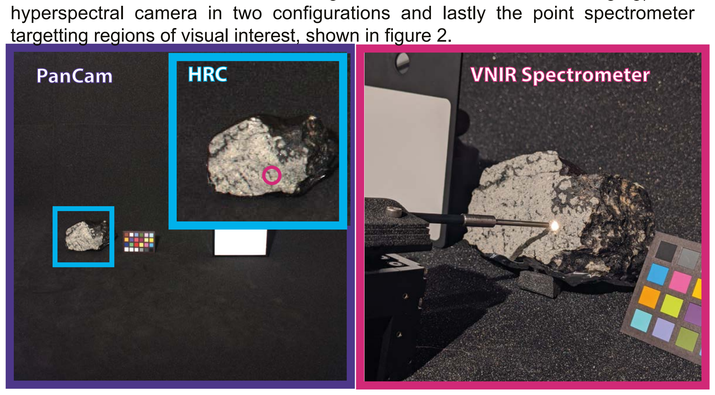


Figure 2. Purple: PanCam field of View. Blue: HRC footprint. Pink, Visible to Near Infrared (VNIR) Spectrometer footprint.

The hyperspectral Camera was positioned at 1m high,1m from the sample plane to provide comparable viewing angles to PanCam, while the VNIR spectrometer was utilised on an X, Y, Z translation stage to stabilise the probe for data collection, targetting regions of visual interest and bulk response. Data was taken in quick succesion under contant and controlled illumination with reference targets for each instrument to allow illumination correction and subsequent comparison of results.

4. SNC Preliminary PanCam results

4a.Shergotty

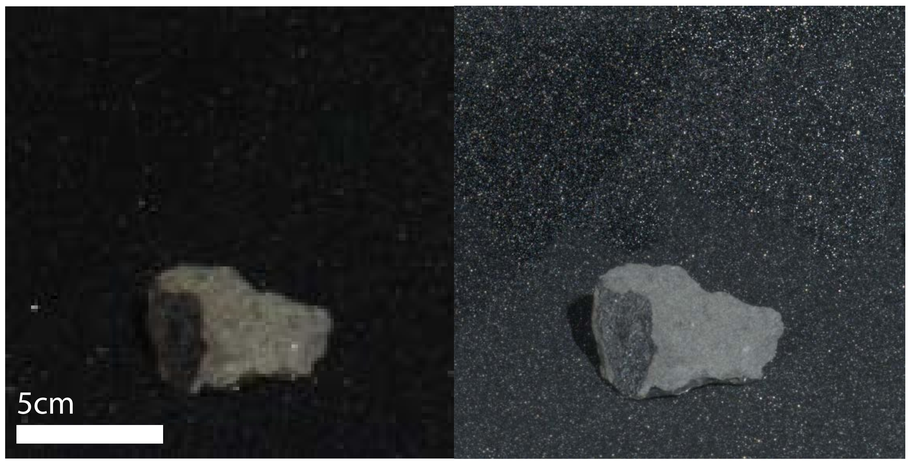


Figure 4a. Shergotty BM.41021 Martian SNC meteorite imaged with PanCam emulator RWAC(Left) and High resolution Camera (Right) at 1.9m distance with both face and crust visable.

4b. Nahkla

Figure 4b. Nahkla BM.1911,369 Martian SNC meteorite imaged with PanCam emulator RWAC(Left) and High resolution Camera (Right) at 1.9m distance.

4c. Chassigny

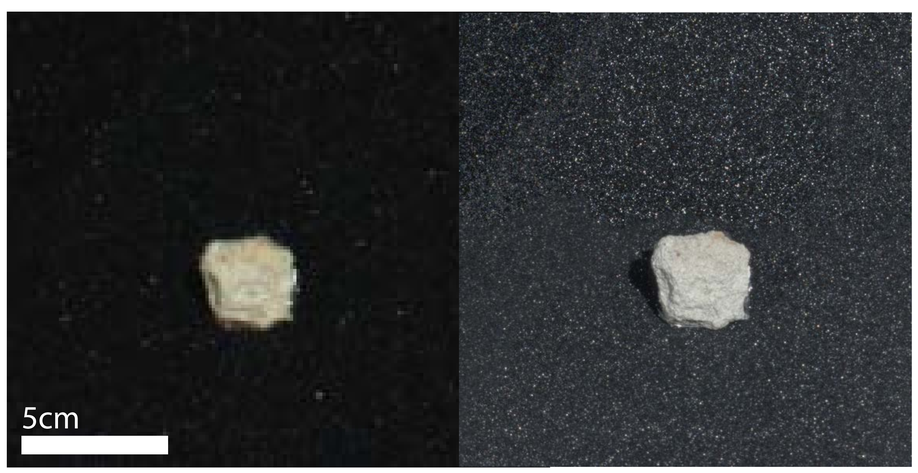


Figure 4c. ChassignyBM.1985,M173 Martian SNC meteorite imaged with PanCam emulator RWAC(Left) and High resolution Camera (Right) at 1.9m distance.

5. SNC Preliminary spectral results

5a. Shergotty spectral comparison

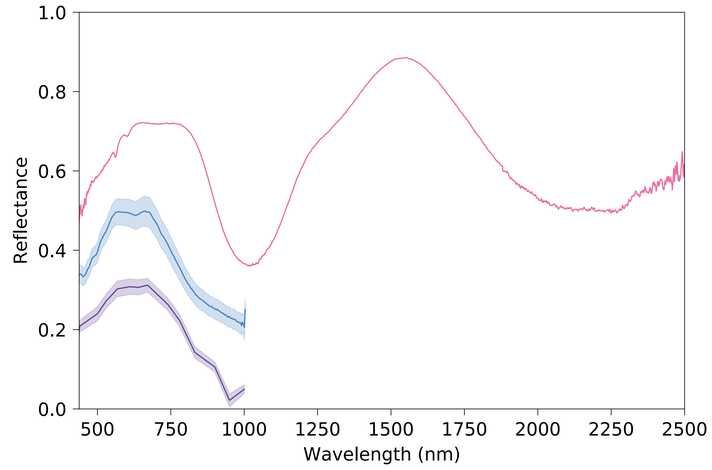
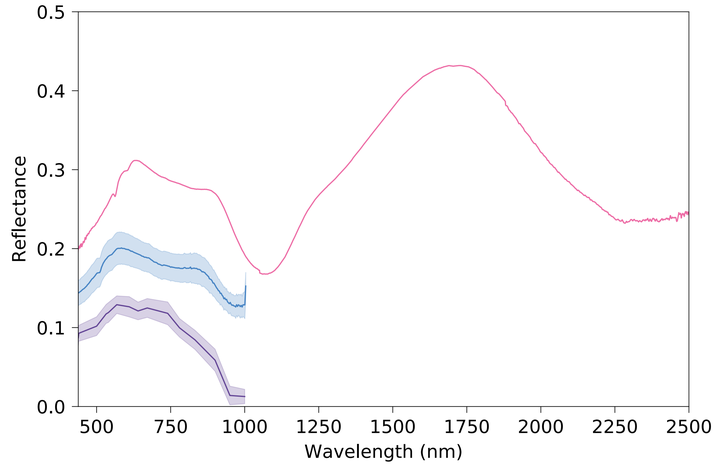


Figure 5a. Shergotty BM.41021 Martian SNC meteorite spectra: VNIR 'contact' spectrometer (Pink), Specim IQ hyperspectral Camera (Blue) and PanCam multispec (Purple). All spectra show shape retention but a decrease if absolute reflectance across the instruments.

5b. Nahkla spectral comparison



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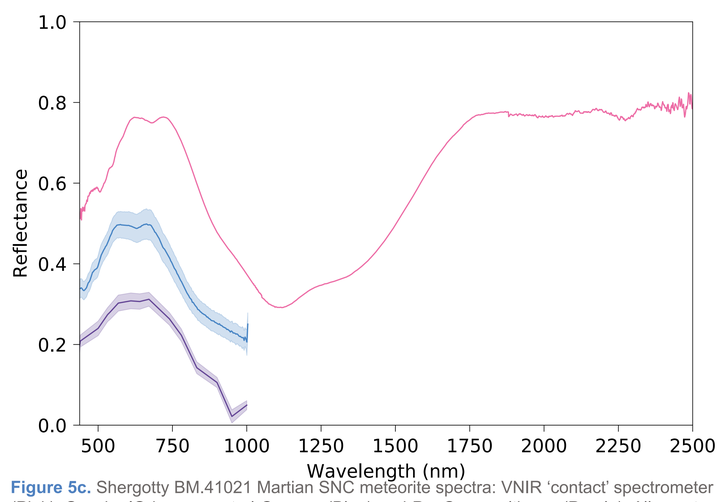

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6.Next Steps

Investigation of the absolute reflectance variation across spectrometer-HS Camera-PanCam including development of surface correction. The Spectral features identified for each of the SNC specimens will be compared to the other SNC meteorite samples and spectral parameter maps developed to identify these features in new sample data. These spectral parameters will be adapted for use during the ExoMars campaign to identify surface features on interest.

References: [1] Vago J. L. et al. (2017) Astrobiology, 17, 471-510 [2] Coates A. J. et al. (2017) Astrobiology, 17, 511-541. [3] Korablev O. I. et al. (2017) Astrobiol- ogy, 17, 542-564. [4] Allender E. J. et al. (2018) Image and Signal Processing for remote sensing XXIV , 10789, 1078901. [5] Chennaoui Aoudjehane H. et al. (2012) Science, 338, 6108, 785-788. [6] Cosuins. C. R. et al. (2012) Planetary and Space Science, 71, 80-100. [7] Ashley J. W. (2015) CosmoELEMENTS, 10-11 . [8] Schröder C. et al. (2016) Nature communications, 7, 13459. [9] Tait. A. W. (2019) LPSC L, #1387

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