COMPOSITIONAL CHARACTERISATION OF THE MARTIAN SOUTH POLAR RESIDUAL CAP USING CRISM. Jacqueline D. Campbell, Panagiotis Sidiropoulos and J-P. Muller. Imaging Group, Mullard Space Science Laboratory, University College London, Holmbury St Mary, Surrey, RH5 6NT, UK (Jacqueline.campbell.16@ucl.ac.uk, p.sidiropoulos@ucl.ac.uk, j.muller@ucl.ac.uk)

Introduction: While Mars was initially thought to have been a non-dynamic planet, repeat observations starting with the Mariner missions of the 1960s [1], and in more recent years by the European Space Agency's (ESA) Mars Express launched in 2003, and by NASA's Mars Reconnaissance Orbiter (MRO) launched in 2005, have shown that the red planet's surface is far more dynamic than previously imagined. In particular, the polar caps exhibit significant seasonal changes. MRO includes an imaging spectrometer, CRISM [2] capable of resolutions of ≈20m, which can be used to analyse composition properties of the icy surface. Mars' south polar cap consists of a permanent 400km diameter layer of solid CO_2 and water ice [3].

"Swiss Cheese Terrain" (SCT) is one of the unique surface features found only in the Martian South Polar Residual Cap (SPRC). Its characteristic appearance (consisting of flat floored, circular depressions) is considered to be caused by seasonal differences in the sublimation rates of water and CO_2 ice [4]; scarp retreat through sublimation may expose dust particles previously trapped in the SPRC which can then be analysed using spectroscopic techniques to establish dust composition. Figure 1 shows typical SCT morphology.

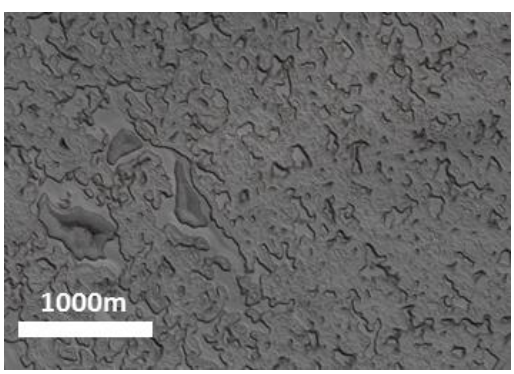

Figure 1: SCT sublimation features (CTX:B08_012572_0943_XI)

Polycyclic Aromatic Hydrocarbons: The primary motivation for this investigation is the detection of polycyclic aromatic hydrocarbons (PAHs), a group of chemical compounds consisting of benzene rings of hydrogen and carbon [6]. PAHs are considered to be important in theories of how life developed on Earth, and the search for organic molecules on Mars is important in ascertaining Mars' past conditions, and current habitability [7].

PAHs are abundant throughout the universe, and have been found to coalesce in space within dust clouds, [8] and have been detected on two of Saturn's icy moons, Iapetus and Phoebe [9]. The delivery of complex organic compounds to established, habitable planets via bolide impact is a very important concept in astrobiology, and could be instrumental in explaining abiogenesis. The ability to identify PAHs using remote sensing could prove a critical tool in the search for putative locations for extra-terrestrial organisms.

To date, the hypothesised connection of Martian Swiss Cheese Terrain and the presence of PAHs has not been systematically examined.

Methods: Only Full Targeted Resolution (FRT) CRISM products have been considered for study to try to maximise spatial resolution (~20m/pixel) of small-scale rim features. Analysis of the SPRC has been carried out using HiRISE, CTX, MOC-NA and HRSC imagery to better constrain regions of interest, and select CRISM scenes for spectral analysis. 72 FRT CRISM scenes were identified as containing SCT; these were arranged into groups of stacked images, resulting in 13 stacks each containing several FRT scenes taken over a period of 3 Martian years, totalling 55 images, which could then be examined for temporal and spatial spectral changes.

The CRISM Analysis Tool (CAT) plugin for ENVI software was used to process the 55 CRISM scenes with corrections for photometry, atmosphere, image artefacts, 'despiking' and 'destriping', and to generate summary products. 44 spectral summary products based on multispectral parameters are derived from surface reflectances for each CRISM observation that can be used as a targeting tool to identify areas of mineralogical interest for further analysis [10]. Those of particular interest to this investigation are those which highlight carbonate overtones, and CO_2 and water ice, in order to differentiate materials of astrobiological interest from the bulk of the SPRC.

Pelkey's summary products were utilized to create RGB composite images of regions of interest to identify regions of spectral difference around dust rims (figure 2).

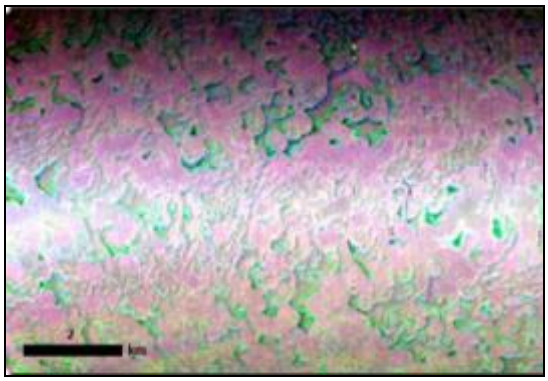

Figure 2: False colour visualization of CRISM scene 00005D24. Red: CO2 ice, Green: H2O ice, Blue: carbonate overtones

Regions of interest were then further analysed, with dark rim and non-rim spectra compared with each other (Figure 3).

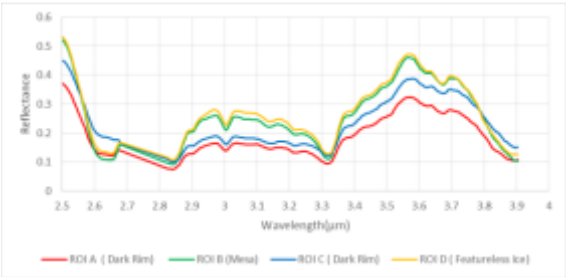

Figure 3: Comparison of dark rim and non-rim region of interest CRISM spectra

Spectral band computations were used to remove the effects of CO_2 and H_2O ice from the spectra. The "corrected" spectra were compared to labarotory data for PAH signatures, and to CRISM mineralogical spectral libraries to identify features.

Conclusions: There are clear spectral differences between dust rims and non-rim regions, with indications of carbonate components within SCT dust rims. CO_2 ice signatures are a limiting factor in identifying PAHs as the removal of CO_2 ice spectra may also remove subtle features in the 3.3μm region of CRISM spectra. This project is ongoing, and in future more detailed results will be presented. Work is currently being carried out to look for compositional changes over time in dust-rich regions, and how spectral changes relate to dust content and morphological processes.

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