The Search for Polycyclic Aromatic Hydrocarbons in the Martian South Polar Residual Cap Using CRISM Infrared Spectra

Jacqueline Campbell (1), (2) Panagiotis Sidiropoulos (2) and Jan-Peter Muller (2)
(1) University of Brighton and (2) Mullard Space Science Laboratory (MSSL/UCL)

Motivation

Polycyclic Aromatic Hydrocarbons (**PAHs**) are considered to be important in **theories of abiogenesis** (Allamandola, 2011) and are thought to be responsible for characteristic short wave infrared (SWIR) **spectral features at 3.29** µm in interstellar dust clouds (Mulas et al., 2005) and on the Saturnian satellites Iapetus and Phoebe (Cruikshank et al. 2007). They have been detected in Martian meteorites, though their origin is controversial and may be the result of terrestrial contamination (Becker et al., 1996).

PAHs exposed at the Martian surface are **rapidly destroyed by UV radiation** (Dartnell et al., 2012). , and therefore it is desirable to identify processes that provide a source of newly exposed material for SWIR analysis.

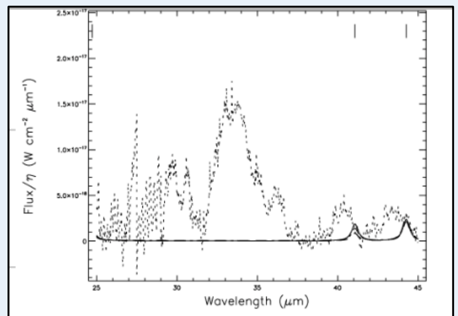

Fig.1: Interstellar spectrum for PAHs, Mulas et al. (2005)

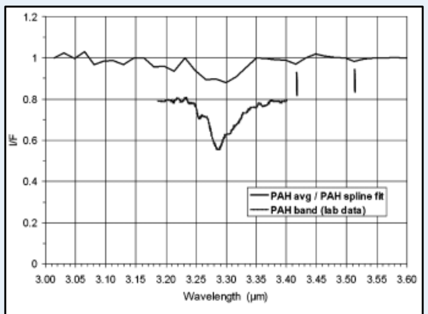

Fig. 2: Iapetus and lab PAH spectra Cruikshank et al., (2008)

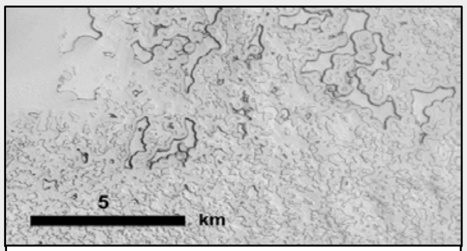

Fig.3: SCT Sublimation Features (CTX:B08_012572_0943_XI)

Background

Swiss Cheese Terrain (**SCT**) is characterised by **sublimation features** unique to the Martian South Pole; their morphology is subject to seasonal changes as CO_2 sublimates during Martian Southern Hemisphere spring and summer. The permanent CO_2 layer at the south pole allows SCT to build up over decades, resulting in dynamic features with a springtime scarp retreat rate of up to 8m/Mars year (Byrne and Ingersoll, 2002).

Sublimation may occur from the base of the CO_2 ice sheet, resulting in the **excavation of dust** trapped within the ice; local ruptures at the surface of the ice allow CO_2 gas jets to erupt, leaving a surface layer of **newly exposed dust**, thought to be responsible for the dark rims visible in Swiss Cheese sublimation features (Kieffer et al., 2006).

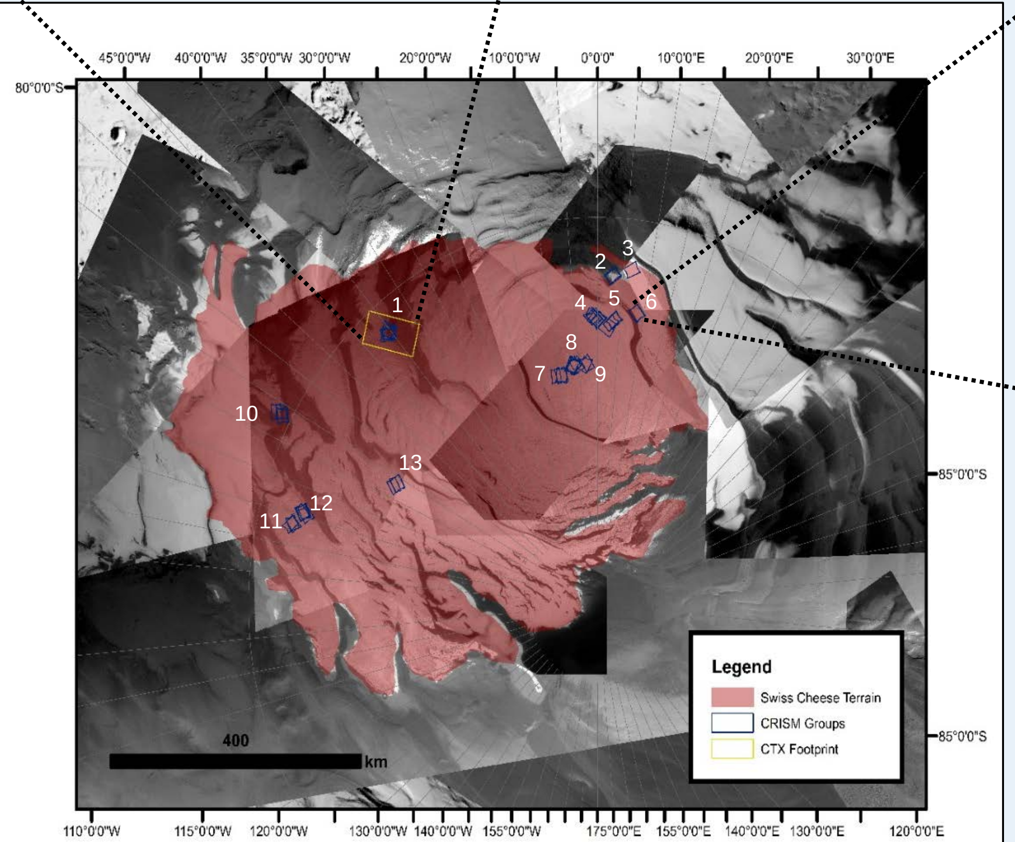

Fig.4: The Martian South Pole; the base map is comprised of HRSC (ND3 and ND4) images, with a resolution of 12.5m/pixel. The images were manually co-registered using ArcMap. The area outlined in rose covers regions where SCT is visible in HRSC images. Overlaid are (1) a CTX footprint to provide a higher resolution (6m/pixel) image of SCT, and, (2) the 13 CRISM groups being used for SWIR spectral analysis.

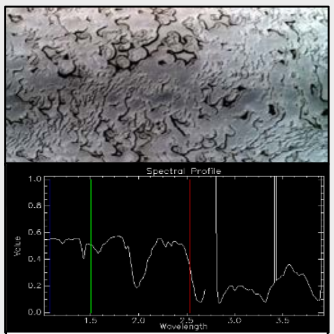

Fig.5: CRISM Scene 00005D24 and its associated IR spectrum

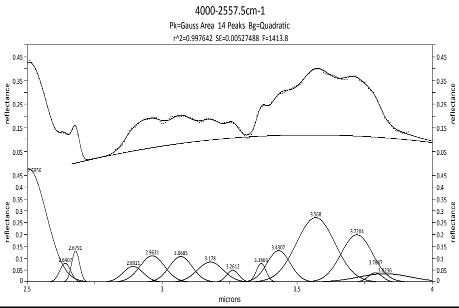

Fig. 6: PeakFit separation of peaks between 2.5-4µm

Current and Future Work

The Compact Reconnaissance Imaging Spectrometer for Mars (**CRISM**) on board NASA's Mars Reconnaissance Orbiter (MRO) provides **hyperspectral imaging data at visible and infrared wavelengths**; 362-3920nm. Starting with 50 HiRISE images identified as SCT, additional images from NASA's MOC-NA and CTX instruments were systematically analysed for widespread SCT coverage. Within this region, 72 Full Resolution Targeted (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.

Each group of images is being examined for **geomorphological and spectral changes over time**, with particular **emphasis on the 3.29µm** spectral region in order to search for evidence of **PAHs**.

Preliminary Results

Initial spectral analysis has revealed **albedo-independent differences** in spectral signatures between **depression floors** and **dark rims** in several CRISM scenes. Spectral mapping using CRISM Analysis Tool summary products reveals **carbonate/organic diagnostic spectral features**, predominantly in young, non-eroded SCT. The 2.5-4µm features of interest are being analysed using PeakFit software for comparison with existing literature to assign known minerals and compounds to individual peaks, and unidentified features are being cross-referenced with organic spectral libraries to look for similarities with PAHs.

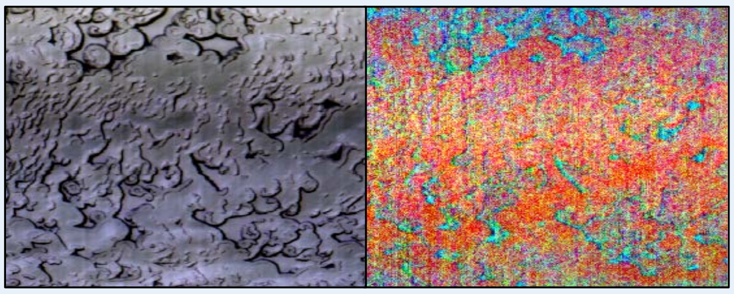

Fig.7: Spectral map of CRISM Scene 00005D24, CAT_ENVI summary products.
RED: CO_2 ice. BLUE: H_2O ice. GREEN: Carbonates/organics

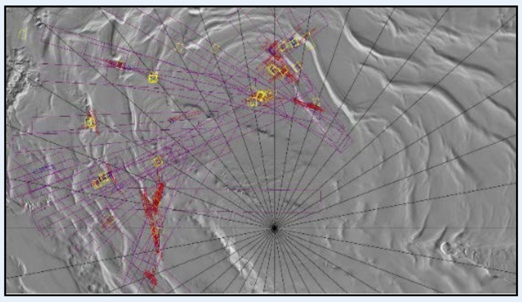

Fig.8: Distribution of SCT footprints from HiRISE, MOC-NA, CTX and CRISM

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