STUDY OF THE 2.7 MICRON ABSORPTION BAND FOUND ON COMET 67P/CG K. E. Johnson[1] and S. Singh[1], T. McCord[1] [1]Bear Fight Institute (22 Fiddler's Rd, Winthrop, WA)

Introduction: The purpose of this study is the analysis of the 2.7 micron absorption band and its co-incident bands. During our study of the calibrated VIRTIS-M spectra of Comet 67 P Churyumov-Gerasimenko from the Rosetta mission we discovered an absorption band at 2.7 microns which presents both in single peak form, and in double peak form. This absorption band only appears in certain locations on the surface, and the single peak form is sometimes correlated with an additional absorption band at 1.15 microns.

Calibration of VIRTIS-M Data: The first step in the calibration of the VIRTIS-M data is calculation of a pseudo flat-field correction. The entire dataset is normalized by the median spectrum taken of the comet nucleus. This corrects for horizontal and vertical artifacts found in the dataset. Next, a histogram of apparent reflectance is created for all the images to determine a median across-track profile, which gives a correction factor used to normalize the median across-track profile. Once these corrections are applied, this gives us the I/F image. Next, the I/F image is divided by the median image and the median spectrum from the dataset, which cancels out the effects from components that are present everywhere on the surface, and allows the more uncommon absorption bands to be more easily seen. Once this correction is applied, a polynomial function is fit the spectrum and divided by it to normalize the spectrum to 1 and assure that the absorption bands are not affected by a slope in the spectrum.

MELSUM: MELSUM stands for Multi Endmember Linear Spectral Unmixing Model. MELSUM relies on the least squares inversion of the system Y=AX where Y is a vector containing the unknown spectrum, A is N*M, a matrix filled with the endmembers spectra, the input spectral library where N is the number of endmembers and M is the number of spectral channels, and X is a vector containing the coefficients of each component in the input library. The solution of this linear system is given by $X = (A^TA)^{-1}A^TY$. MELSUM automatically selects the best linear combination of spectral endmembers from the reference library. It also provides strictly positive mixing coefficients values, which is not the default property of the least-squares inversion. This tool allows the user to fix the maximum number of spectral endmembers used to model a mixture [1].

2.7 Micron Absorption Band: During our examination of the VIRTIS-M dataset we came across a relatively strong absorption band centered at 2.7 microns. This absorption band has a strength of up to 4% in the poly-corrected spectrum and comes in two forms, a single peak band and a double peak band. The single peak 2.7 micron band is sometimes associated with a weaker band centered at 1.15 microns.

How we found it. We began our search by comparing the I/F image, the division by median image and median spectra image, and the poly-corrected image all viewed at 2.717 microns and looking for any places where there appeared to be an absorption at 2.7 microns. Initially, we found one place with a particularly strong single peak 2.7 micron absorption of approximately 4%, that was easily visible in the poly-corrected spectrum (see Figure 1).

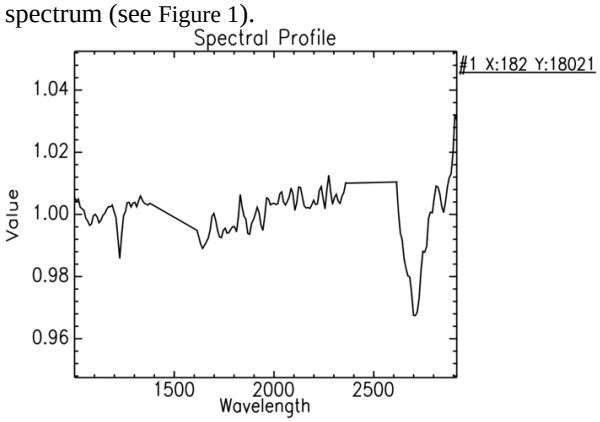

Figure 1 Poly-corrected spectrum of an example of the single peaked absorption band found at 2.7 microns.

We ran the poly-corrected spectrum of that location against the entire poly-corrected image through MELSUM in the hopes of locating any other areas with the same (or similar) spectrum. We then took the mixing coefficients and the RMS values (RMS values of the fit of the sample spectrum) created by MELSUM and divided them to create a more sensitive parameter for our evaluations. Using the image created by dividing the mixing coefficient of each pixel by its RMS value we were able to locate several more locations which had a 2.7 micron absorption band, both of the single peak and double peak variety. We also created a band depth image which calculated the depth of the 2.7 micron band for every pixel in the poly-corrected image, and another band depth image which multiplied the band depth at 2.7 microns with the band depth of the 1.15 micron band. Using these images and the image created from the MELSUM results we were able to locate several more locations with a noticeable 2.7 band, with some locations having a single peak band and some having a double peak band.

We then used MELSUM to compare both the single peak absorption band and the double peak absorption band to a spectrum of pure CO_2 ice (see fig 2).

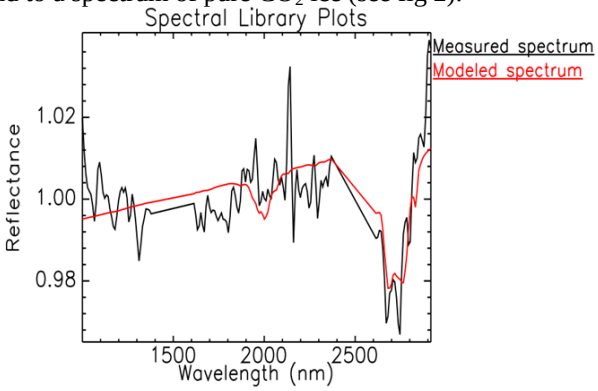

Figure 2 Spectrum with a double peak 2.7 micron absorption modeled by CO_2 ice using MELSUM

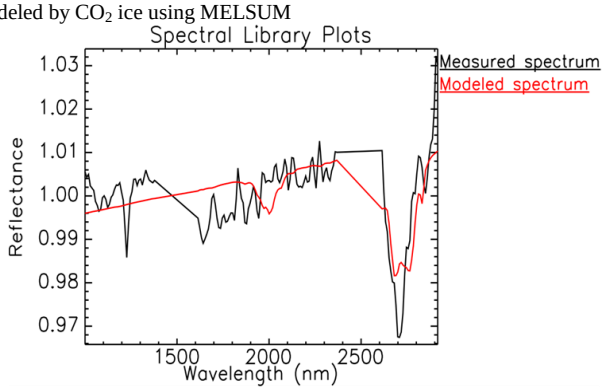

Figure 3 Spectrum with a single peak 2.7 micron band modeled by CO_2 ice using MELSUM

Conclusions: There is a 2.7 micron absorption present on comet 67P which can have either a double peak or a single peak and a secondary absorption band at 1.15 microns. We are currently searching for candidate materials for it, and it is possible that the double peaked absorption band is CO_2 ice.

References: [1] Combe J-Ph. 2008 Icarus