CALIBRATION OF MARS EXPRESS COLOR DATA K. E. Johnson[1] and J-Ph. Combe[1], T. McCord[1] [1]Bear Fight Institute (22 Fiddler's Rd, Winthrop WA)

Introduction: The purpose of this study is to calibrate the color data from the Mars Express mission. We did this through a comparison of the HRSC (High Resolution Stereo Camera) data and the OMEGA (Infrared Mineralogical Mapping Spectrometer) data. We compared each of the color channels in nine HRSC files to the corresponding channels in overlapping OMEGA files. The HRSC images have nine channels "a panchromatic nadir-looking (N) channel, four color channels (R, G, B, IR), and 4 other panchromatic channels for stereo imaging or photometric imaging".[1]. The OMEGA instrument has five channels, blue, green, clear filter, red and IR. We then reconstructed the spectra using the peak position in the histograms of apparent reflectance.

Calibration:

Selecting the HRSC file: We started with a list of 16 possible HRSC files that we could process and use for the calibration. Our first step was to look at the signal chain ID of each of the nine channels of the HRSC file and select only those files that had a unique set of signal chain IDs. The signal chain ID refers to the path through which the data collected from a channel passes. There are four possible channels, labelled 0 through 3. We were looking for HRSC files with different sets of signal chain IDs because we wanted to be sure that there weren't any systematic effects from the paths the signals were taking. Once we had found the nine HRSC files with unique sets of signal chain IDs, we looked at each of the HRSC files to make sure that there was a clear view of the ground (no cloud cover or dust storms) and that it was well illuminated. Once we had selected our HRSC files, we moved on to selecting the OMEGA files that would correspond to each of the HRSC files.

Selecting the OMEGA files: We begin by outlining the coordinates of the area covered by one of the Mars Express HRSC images. Then we look for all of the Mars Express OMEGA images which overlap with the HRSC image footprint. We then calculate the solar longitude of the HRSC image and of all of the OMEGA images and select the OMEGA images that have a solar longitude within $\pm$ 10^{o} of the HRSC image. We do this to ensure similar seasonal conditions in the HRSC and OMEGA images because sometimes the HRSC and OMEGA images are taken years apart. We then take the remaining OMEGA images and compare the footprint of the HRSC image to the footprint of each of the OMEGA in sequence so that we could select only the OMEGA images which overlap completely or nearly completely with the HRSC image.

We then ran the OMEGA .nav and .qub files through a calibration program which gave us a file with all of the necessary information to project the file and use it in the rest of the calibration. We resampled this image to the HRSC resolution. We then created a .geo file using the specifications in the HRSC image. We used that .geo file to project the OMEGA files so that we could measure the latitude and longitude in the middle of the file which we used along with the time of data collection taken from the OMEGA .nav file to calculate the local solar time and solar incidence angle for all of the OMEGA files. We also calculated the local solar times and solar incidence angles for the HRSC file at the same latitude and longitude as each of the OMEGA file, but using the time of data collection from the HRSC file. We did this so that we could compare the local solar time and solar incidence angle of the HRSC and OMEGA files at the location of each of the OMEGA files. We then selected the OMEGA files which had solar incidence angles reasonably close to those of the HRSC file.

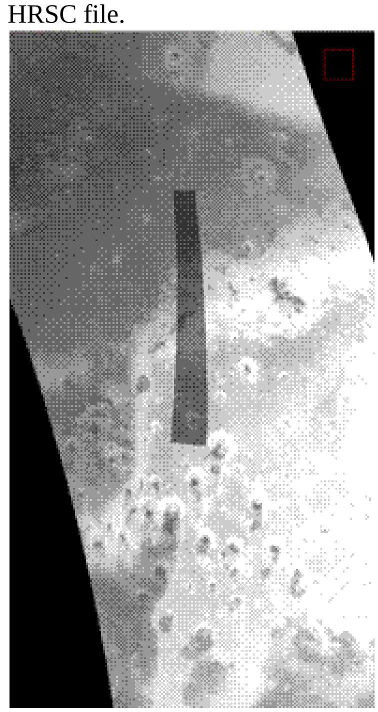

Figure 1 **HRSC image taken from orbit d276, with OMEGA image taken from orbit 3718_3**

Processing the OMEGA and HRSC files: We repeated the process outlined next for each OMEGA file associated to each HRSC file for each of the nine channels in each HRSC file. We compared the HRSC color channel to the corresponding color channel in the OMEGA images. For example, if the HRSC file had two OMEGA files associated with it, this process would be completed a total of 18 times.

First, for each OMEGA file that corresponded to the HRSC file, we created two mosaics, one with the projected OMEGA file on top of the HRSC file (see Fig. 1) and one with the HRSC file on top of the OMEGA file. Next, we took the mosaic with the OMEGA file on top and multiplied it by 0 using ENVI bandmath to create a file that was the same size and shape as the total mosaic but did not contain any data. We did this so that we could create two more mosaics, one with the 0 file underneath the OMEGA file to create a file the same size and shape as the total mosaic but which only contained the OMEGA file, and one with the 0 file underneath the HRSC file for the same reason. We then used the mosaic of the OMEGA file on top of the HRSC to create a Region Of Interest (ROI) of just the area where the HRSC file and the OMEGA file overlap. We used this ROI to subset the OMEGA only and HRSC only images so that we could have files containing the OMEGA and HRSC data from only the areas where they directly overlap.

Next we exported each image window into an IDL variable, and created histograms of the reflectance vs the number of pixels of each reflectance value, and we saved these as spectral libraries. For the histograms taken from the HRSC file, we applied the reflectance scaling factor to the x-axis as given in the HRSC image's label file.

Reconstructing the Spectra: Once we had histograms comparing each HRSC color channel to the corresponding OMEGA color channel, we measured the location of the peak of each histogram, which told us the peak reflectance value, which is the reflectance value which has the highest number of pixels in the image with that reflectance value. We then made plots of the peak position in the histogram for each color channel vs the color's wavelength (blue – 442 nm, green – 534 nm, nadir – 678 nm, red – 750 nm, IR – 946 nm) for both the HRSC file and its corresponding OMEGA file (see Fig. 2).

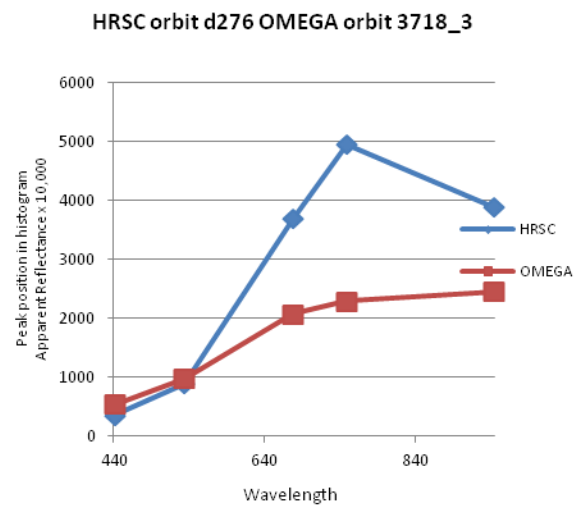

Figure 2 Reconstructed spectra using data from the HRSC image taken in orbit d276 and the OMEGA image from orbit 3718_3. The x axis is the wavelength of the color channel, and the y axis is the peak position of the apparent reflectance x10,000

Conclusions*:* All of the reconstructed spectra from the HRSC data shows a high peak at the red channel, which is to be expected. The OMEGA green, red and IR data points are always lower than the HRSC, but the OMEGA blue data point is above that for the HRSC in 25 out of 30 cases, and the OMEGA nadir point is above the HRSC in 14 out of 30 cases. The ratio between the HRSC data point and the OMEGA data point is the calibration ratio.

References: [1] McGuire, P.C. and Audouard, J. LPSC Abstract (2016) #1031