MULTI-RESOLUTION APPROACH TO THE SPECTRAL ANALYSIS OF MARTIAN OUTCROPS. L. Pompilio[1], G. Tampella, A. Lisotti, A. P. Rossi[2], and M. Sgavetti[1], [1]University of Parma, Via G.P. Usberti 157/A, 43100 Parma, Italy (loredana.pompilio@unipr.it), [2]ISSI, CH.

Introduction: Among the space-based spectrometers in the visible-near infrared range that visited Mars in recent years, the Observatoire pour la Minéralogie, l'Eau, les Glaces et l'Activité (OMEGA) and Compact Reconnaissance Imaging Spectrometer (CRISM) are indeed the most powerful ones. Both are hyperspectral imaging spectrometers operating within the ranges 0.38 to 5.10 [1] and 0.4 to 4.0 micrometers [2], respectively. The spatial resolution is variable for both the instruments, ranging from 0.350 to 4.0 km/pixel and 15 to 200 m/pixel, respectively, according to the operating mode. The CRISM instrument also allow both multi and hyperspectral surveys to be accomplished. This remarkable operational flexibility allows the compositional information at regional and local scales and very detailed investigations to be acquired as well.

Here we present the multi-resolution approach to the spectral analysis of Martian data and outline the future work. The area of interest is localized at about 4°30' N and 10°30' W (Fig. 1), within the Crommelin crater, where extensive light-toned deposits (LTDs) outcrop on the crater floor [3]. The multiscale survey of the Crommelin crater is accomplished where possible by using overlapping OMEGA and CRISM measurements.

Demonstrative results of the multi-resolution approach to the interpretation of the spectral variability of a multispectral survey are shown for a terrestrial area, through multispectral Landsat TM5 data.

The main purposes of the present investigation are: a) to allow the detailed investigation of specific areas of interest; b) to evaluate the sensitivity of measurements to the compositional variations at the local and regional scales; c) to establish detection limits of features diagnostic for specific materials.

Data and methods: we plan to apply the multi resolution approach to the spectral analysis of the LTDs deposits observed at the bottom of the Crommelin crater we use OMEGA (orbit 0314_2) and CRISM data (observations HRL000064B2_07; MSW00002FCA_01 and MSW00003AE0_01). All those scenes partially overlap on a small rectangular area about 2x8 km^2 localized on the crater floor, at the base of the central bulge. Here, the layered LTDs are locally interbedded with darker materials.

Before going into details about the analytical method, let we first state that we accomplish all the calculations in an n-dimensional hyperspace, where the n dimensions are set equal to the number of spectral channels per observation.

Prior to apply any mapping methods to the data, we normalize the spectral dataset via the conversion of the original atmospherically corrected I/F spectra into more appropriate unit vectors, thus to minimize the effect due to the light scattering, topography and possibly the regolith. As a consequence, at this stage we avoid any speculations about textural properties of the materials. Nevertheless, we strongly enhance the spectral variability within each single data cube, as shown in figure 2.

Due to the high sensitivity to subtle spectral variations of the normalized dataset, effects due to striping pixels and smile have to be removed prior to apply normalization. This is especially relevant for CRISM data, which show both the effects.

An acceptable number of endmember spectra are then selected within each data cube using various methods, both supervised and unsupervised, according to the degree of spectral variability, the level of accuracy of the spectral classification and the special interest toward certain spectral shapes. As an example, by using a geologic criterion, the analyst could find convenient to use comparable or higher resolution imagery as a support for spectral selection.

At this point, the classification algorithm will cluster the pixels of each scene around the proper endmembers, using a technique of minimization of residuals. According to the selection rules which drive the definition of the endmembers to use per observation, and the threshold used for pixel clustering, we will give an interpretation of the classification results.

This method will apply to the whole dataset made of multiscale observations and thus estimates of the sensitivity of the technique to compositional variations at local and regional scales, as well as detection limits of features diagnostic for specific materials can be assessed.

Demonstrative results: So far, the multi-resolution approach to spectral analysis has been applied to a multispectral Landsat TM5 acquired on Sicily (Italy). The main advantages of this target are: a) multispectral remote-acquired data are compared with hyperspectral lab data; b) Landsat TM5 data allow very accurate preprocessing operations, since the long time operability of this instrument; c) the reference spectral library includes samples collected at the site area.

The remote spectral data have been classified using laboratory spectra measured on rocks sampled throughout the area and especially belonging to Messinian age deposits. Compared to the 6 spectral channels of TM5 data in the VNIR range, lab measurements have a remarkably higher resolution. In addition, the measurement conditions are completely different due to the experimental setup.

In spite of those differences, the normalization and classification techniques above described return appreciably good results (Fig. 3).

References:

[1] Bibring J. P. et al. (2004) *2004ESASP1240*, ISBN 92-9092-556-6, 37 - 49. [2] Murchie S. et al. (2007) *JGR, 112,* doi:10.1029/2006JE002682. [3] Rossi A. P. et al. (2008) *JGR, 113,* doi:10.1029/2007JE003062.

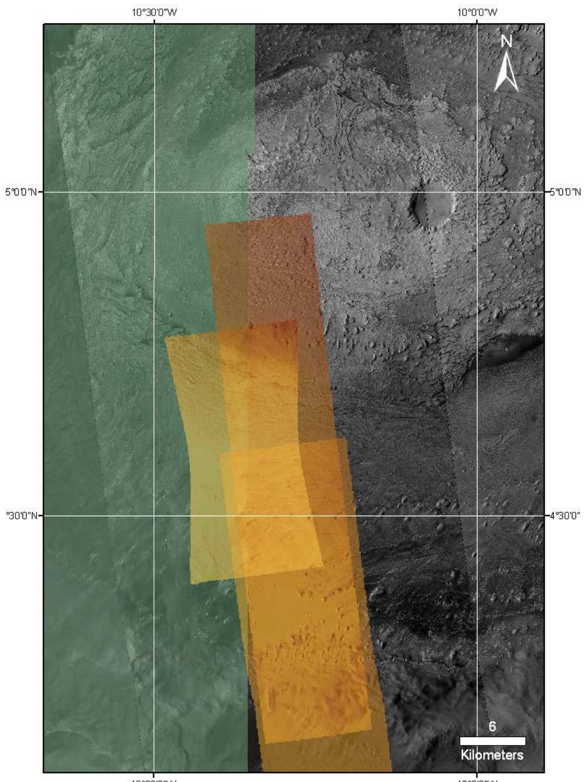

Figure 1. Location of the area of interest for this study within the Crommelin crater, where the CRISM (orange) and OMEGA (green) footprints overlap. Part of the central bulge is visible at the top.

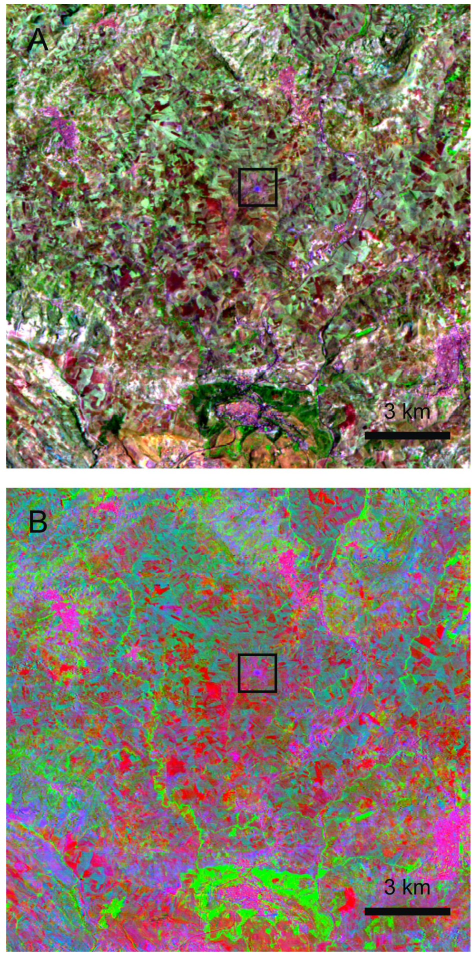

Figure 2. Comparison between the calibrated and atmospherically corrected Landsat TM5 [7,4,1] (A) and the same as a result after the application of normalization (B). Black square indicates the area where spectra of figure 3 come from.

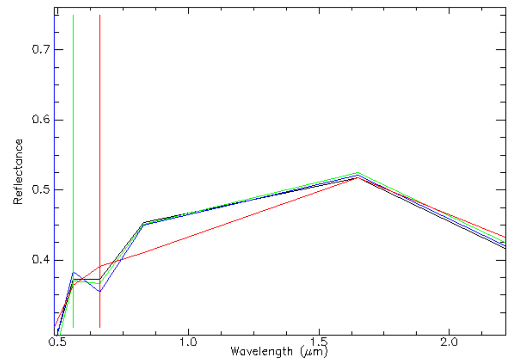

Figure 3. Comparison between an endmember spectrum (red line) from lab measurement and some of the best match to it, found within the black square of fig. 2.