**MULTISPECTRAL MICROSCOPIC IMAGING FOR PLANETARY EXPLORATION.** D. Rajmon, Charles University, Faculty of Sciences, Institute of geochemistry, mineralogy and mineral resources, Albertov 6, 128 43 Prague 2, Czech Republic; E-mail: rajmon@mail.natur.cuni.cz

Our understanding of different bodies in the solar system raised rapidly during the last forty years. This was allowed mainly by robotic and manned space missions. Among terrestrial bodies the Moon is probably the best understood. It was achieved, to a large extent, thanks to petrologic studies of returned samples at a microscopic scale. We have got no data with a submilimeter resolution from other bodies up to date. However, microscopic study of rocks is a traditional and basic method giving important constraints for petrologic models. Therefore, a camera imaging at a submillimeter scale was developed as a new instrument for the planetary exploration. Subsequently, a combination with the reflectance spectrometry was suggested [1].

Mars is in the center of interest of a scientific community, at the present time. Therefore, the demonstration of the microscopic multispectral imaging has been done with respect to exploration of Mars.

The multispectral microscope can deal with a wide variety of targets on Mars including magmatic, sedimentary and contact metamorfic rocks. The most important rock-forming minerals are olivine, pigeonite, and augite [2]. The most probable constituents of Martian soil are nanophase or amorphous hematite, iron oxyhydroxides, palagonite, Fe-rich smectites and salts (sulfates) [3].

A number of samples have been prepared including pure minerals, mineral mixtures, rocks, and the Martian and Moon soil analogs. A part of these samples has been imaged with the Hitachi camera providing a general view of a 41 × 56 mm or 30 × 41 mm with a resolution 74.8 µm/pixel or 54.6 µm/pixel respectively. A part of the samples has been imaged with the CompuScope CCD camera. This camera displayed in a detail an area of 2.6 × 3.9 mm with a resolution 5.1 µm/pixel. Images have been acquired at 10 spectral channels. Eight wavelengths have represented positions where important absorption features occur - 0.45, 0.50, 0.57, 0.63, 0.66, 0.69, 0.80 and 0.85 µm. Two wavelengths have been chosen out of any important absorptions to represent overall reflectivity of a sample - 0.60, and 0.75 µm. Originally, the Mikrotel camera developed by Max Planck Institute in Mainz and DLR in Berlin for planetary mission was intended to be used. However, several technical problems prevented from using it. On the base of work with all three cameras several constraining features have been evaluated.

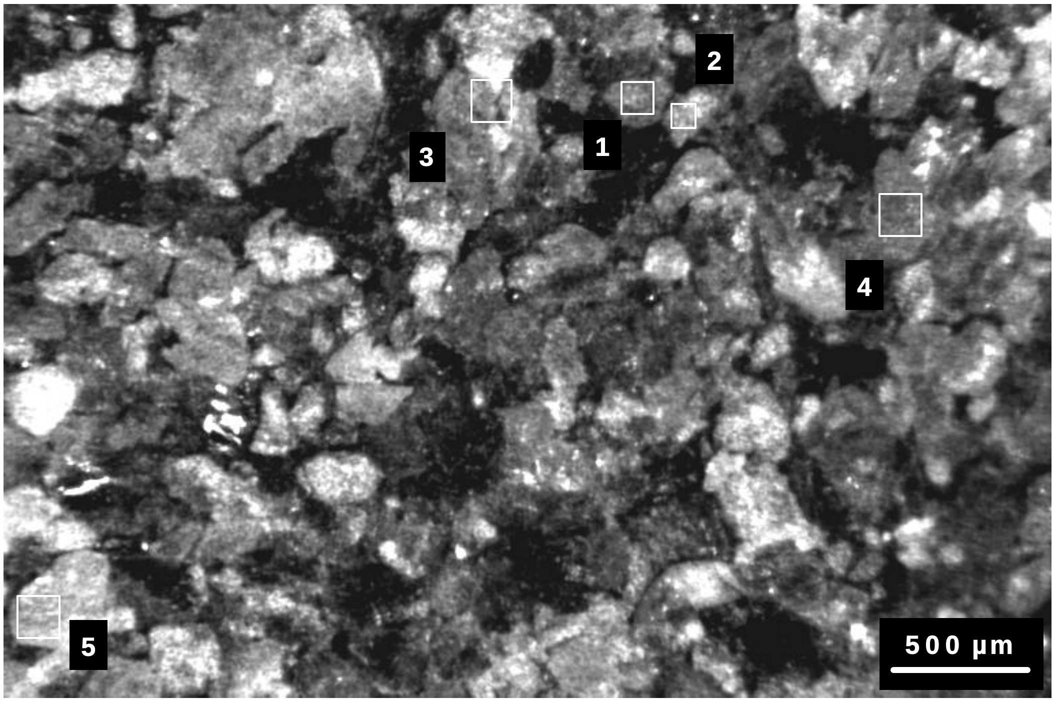
A number of images of different possible Mars surface constituent minerals and rocks has been acquired. Different morphologies and structures allowing a precise petrographic characterization of a sample are clearly distinguishable. A stereoscopic imaging is strongly recommended. Studies of Martian volcanic rocks and soil require a resolution at the scale at least of tens of micrometers or, better, units of micrometers. A bigger CCD chip than 200 x 200 pixels should be used and thus, with a constant field of view, the resolution and focus depth could be higher. The imaging with 256 degrees of shadow is sufficient for moderately contrast samples but samples with a higher contrast, e.g. due to reflections, will require more degrees of shadow. Higher dynamic range will also improve the quality of spectral data. The dynamic range can be thresholded and recomputed to lower range if necessary. An internal illumination will be necessary because of a short-distance viewing geometry preventing sunlight to fall on a sample. A small monochromator is suggested.

Spectra of several samples have been modeled. The mixture of olivine, augite, labradorite, and limonite was studied in a more detail. The spectra of five individual grains of the mixture have been modeled and interpreted to a great degree of certainty. Spectral data obtained through imaging at several wavelengths will help to determine minerals of a sample and thus to improve its petrologic characterization. An interpretation of mixture spectra is difficult because of non-linear spectral mixing. The single-grain spectra provide a good base for the interpreting of a mixture spectra. The single-grain spectra will allow not only easier identification of minerals but they will also allow to estimate contribution of each mineral to spectral signature.

Microscopic multispectral imaging can also be applied to search for some forms of life on Mars similar to extremophiles found in/on rocks in Antarctica or deep see vents. Reflectance spectra could comprise wavelengths indicative of natural coloring pigments, UV fluorescent organisms. Coloring technics could be applied as well as long term observations monitoring changes through time.

A combination of geochemical and spectral analyses and microscale imaging will provide a complex and powerful instrumentation for planetary missions.

[1] Carlton A. et al. (1996), Planetary surface instruments workshop (Meyer C. et al. ed.), LPI Tech. Rpt. 95-05, 105-110, LPI Houston; [2] Treiman A.H. (1995), J. Geophys. Res., 100, 5329-5340; [3] Banin A., Clark B.C., Wänke H. (1992), In Mars (ed. H. H. Kieffer et al.), Chap. 18, 594-625, Univ. Arizona Press




**Figures**: Image of the mixture of olivine, augite, labradorite, and limonite acquired at 630 nm. (Imaged area: 2.6 x 3.9 mm) Small squares with numbers define areas where spectra of individual grains were measured. Plots underneath show spectra of the mixture and its constituting phases. Spectra of the individual grains are shown separately for clarity. If plotted together with the spectra of the mixture and its constituents spectra of the individual grains can be related with corresponding mineral spectra. Data at 690 nm for 01m (olivine) were not correct and thus they were excluded. The spectral signature of the mixture is strongly affected with that of labradorite and limonite. Indeed, three of five measured grains were identified as labradorite. All mineral spectra are affected with the limonite spectral signature, probably due to the coating of mineral grains with fine limonite dust.