Raman Microscopy of Samples of Martian Analogue Material with Cyanobacteria.

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Introduction Raman Laser Spectrometer - RLS - onboard ExoMars 2018 will perform measurements on Mars to identify organic compounds and mineral products as an indication of former and recent biological activity. The measurements will be performed on crushed powdered samples inside the Rover's ALD (Analytical Laboratory Drawer). The objective of the presented investigation is to analyze the influence of the crushing process on the Raman spectra. This is done by comparing Raman spectra of polished solid samples with those of crushed samples. The second objective is to study Raman spectra of crushed samples with cyanobacteria in regard to the discrimination of the cyanobacteria from the mineral background. Appropriate measurement parameters (e.g. integration time and number of repetitions) for the determination of the mineral composition as well as the detection of biological material are derived. A measurement regime is proposed for mineral mixtures with cyanobacteria on the basis of the RLS instrument characteristics. **Sample Choice and Preparation** Orbital observations showed that in general the phyllosilicate deposits do not occur together with the sulphate deposits [1]. Thus the Mars simulant mineral mixture is assigned to phyllosilicatic and sulfatic Mars regolith. The minerals and rocks are chosen to be structurally and chemically similar to those identified in Martian meteorites [2] and on Mars by recent orbiter and rover missions [3], [4]. The Martian analogue rocks and minerals are crushed and only fragments smaller than 1 mm are used for the mineral mixtures. The powder is pressed with 4.5 MPa to retrieve pellets with a smooth surface for better sample handling. Cyanobacteria are chosen as candidates for potential life on Mars. **Experimental Setup** The Raman measurements are performed with a confocal Raman microscope Witec alpha300 R system at room temperature under air at ambient pressure. The Raman laser excitation wavelength is 532 nm. The spectral resolution of the spectrometer is 4-5 cm^{-1}. A Nikon 10x objective is used. The spot size on the sample is in focus about 1.5 μm. The laser power of 1 mW on the sample is chosen. This value is proposed for the RLS instrument on ExoMars. Values of integration time are taken between 1 s and 100 s per measurement and 1 to 100 measurement repetitions at one point on the sample. First, measurements are carried out on the polished solid samples. Then measurements are performed on each Martian analogue powder sample without bacteria and on pure cyanobacteria seperately. Third, measurements are made on the pellets with cyanobacteria. **Results and Summary** The Raman spectrum of cyanobacteria is influenced by the Raman signal of the mineral background. If cyanobacteria are present, β - carotene is the dominant feature in the spectrum. To get optimal spectra of the mineral mixtures of phyllosilicatic and sulfatic Mars and the cyanobacteria the integration time needs to be adjusted. Only short measurement time should be used to avoid saturation of the spectrum of β - carotene. If cyanobacteria are not present, a longer integration time can be applied, which is necessary to identify the different mineral constituents of the sample. To propose a measurement regime for mineral mixtures with cyanobacteria the procedure should start with a measurement time of only a few seconds. In a next step the time and the number of repetitions need to be increased until acceptable spectra of minerals are obtained. For a laser power on the sample of 1 mW the measurement time should be selected between 1 s (for cyanobacteria) and 20 s (for minerals). **Acknowledgement** This research has partly been supported by the Helmholtz Association through the research alliance "Planetary Evolution and Life".

References

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