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Identification of microbial pigments in evaporitic matrices using Raman spectroscopy

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An evaporitic environment is considered as one of the possible habitats for life on Mars. From terrestrial geological scenarios we know that microorganisms inhabiting such an extreme environment (halophiles) are rich in protective pigments, depending on the metabolic pathways and specific adaptation to the harsh environmental conditions. Carotenoids typically occur within the cells of halophiles (bacteria, archaea as well as eukaryotic algae) in large amounts as part of their photosystem and protective adaptation to high doses of UV radiation that are typical for most recent evaporitic environments. Chlorophyll occurs in halophilic cyanobacteria together with carotenoids and possibly other pigments which are synthetised in response to the high UV radiation insolation.
Here we present the results of Raman spectroscopic investigations of a) beta-carotene in experimentally prepared mixtures with halite, gypsum and epsomite; and b) cyanobacterial colonies inhabiting real halite and gypsum matrices in the Atacama Desert.
Our results demonstrate the possibility of detection of beta-carotene – a typical carotenoid – in relatively low concentrations within the evaporitic powdered mixtures; the lowest concentration of carotenoid signal detected was 0,1 mg kg-1, which represents 100 ppb.
Raman spectroscopic analyses of natural specimens (endolithic cyanobacteria) from the Atacama desert revealed the presence of scytonemin, an extremely efficient UV protective pigment, carotenoids of various types and chlorophyll.
The detection potential as well as limitations of Raman spectroscopy as a part of a payload within future robotic space missions focused on the search for life on Mars is discussed.