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Preservation of Raman biosignatures in cyanobacteria and green algae after space exposure

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The BIOMEX (BIOlogy and Mars EXperiment) experiment aims at investigating the endurance of extremophiles and stability of biomolecules under space and Mars-like conditions in the presence of Martian mineral analogues (de Vera et al. 2012). To this end, extensive ground-based simulation studies and a space experiment were performed. Indeed, BIOMEX was part of the EXPOSE-R2 mission of the European Space Agency which allowed a 15-month exposure, on the outside of the International Space Station, of four astrobiology experiments between July 2014 and February 2016. The preservation and evolution of Raman biosignatures under real space conditions is of particular interest for guiding future search-for-life missions to Mars (and other planetary objects) carrying Raman spectrometers (such as the Raman Laser Spectrometer instrument on board the future ExoMars rover). Among the potential biosignatures investigated, the photoprotective carotenoid pigments (present either in photosynthetic organisms such as plants, algae, cyanobacteria and in some bacteria and archaea) have been classified as high priority targets for biomolecule detection on Mars and therefore used as biosignature models due to their stability and easy identification by Raman spectroscopy (Böttger et al. 2012). We report here on the first results from the analysis of two carotenoids containing organisms: the cyanobacterium Nostoc sp. (strain CCCryo 231-06; = UTEX EE21 and CCMEE 391) isolated from Antarctica and the green alga cf. Sphaerocystis sp. (strain CCCryo 101-99) isolated from Spitsbergen. Desiccated cells of these organisms were exposed to space and simulated Mars-like conditions in space in the presence of two Martian mineral analogues (phyllosilicatic and sulfatic Mars regolith simulants) and a Lunar regolith analogue and analyzed with a 532nm Raman microscope at 1mW laser power. Carotenoids in both organisms were surprisingly still detectable at relatively high levels after being exposed for 15 months in Low Earth Orbit to UV, cosmic rays, vacuum (or Mars-like atmosphere) and temperatures stresses regardless of the mineral matrix used. Further analyses will help us to correlate these results with survival potential, cellular damages or stability and the different extremophiles tested in the BIOMEX experiment.