Preservation of carotenoids in cyanobacteria and green algae after space exposure: a potential biosignature detectable by Raman instruments on Mars

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Forty years after the Viking missions, International space agencies are ready to resume the search for life on Mars (and in our Solar System). Indeed, new instruments are able to detect traces of extant or extinct life. They will be sent to Mars on-board the two next rovers: ExoMars2020 and Mars2020. Among them, instruments based on Raman spectroscopy are very promising thanks to their capacity to identify both the mineralogical context and organic molecules of potential biogenic origin. However, in order to support these future missions, it is very important to investigate the degree of preservation and the evolution of potential biosignatures under simulated and real space conditions by Raman spectroscopy. To this end, 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). BIOMEX was part of the EXPOSE-R2 mission of the European Space Agency which allowed a 15-month exposure, on the outer side of the International Space Station, which comprises also three other astrobiology experiments between July 2014 and February 2016. 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 a model biosignature 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 conditions and to simulated Mars-like conditions in space. They were cultured on Martian mineral analogues (Phyllosilicatic and Sulfatic Mars Regolith Simulants) and a Lunar regolith analogue and analyzed with a 532nm Raman spectroscope operating 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.