Detection of new biomarkers on lichens with Raman spectroscopy after space- and Mars like conditions: Results of BIOMEX-EXPOSE R2

R. de la Torre Noetzel[1], L.G Sancho[2], J. P. de Vera[3], M. Baque[3], U. Böttcher[4], E. Rabbow[5], J. Martinez-Frias[6], and M.R. Lopez Ramirez[7]

(1) INTA, National Institute for Aerospace Technology, Spain; (2) UCM, Univ. Complutense Madrid, Spain; (3) DLR, German Aerospace Center, Management and Infrastructure, Astrobiological Laboratories, Germany; (4) DLR, German Aerospace Center, Institute of Optical Sensor Systems, Germany; (5) DLR, German Aerospace Center, Cologne, Germany; (6) IGEO-CSIC, Univ. Complutense Madrid, Madrid, Spain; (7) UMA, Dto. Química-Fisica, Málaga, Spain

Presentation: Tuesday 13:15-13:30
Session: Traces of life, biosignatures, life detection

Abstract:
Exploration of the solar system, needs science and technology support to work at a merged way. Space platforms, such as EXPOSE, are a priority for the performance of experiments which are focused on the exploration of the limits of terrestrial life, trying to get responses to some questions, such as the 1) survival capacity of biological organisms in space, 2) the effects of space environment on no protected biological and chemical material and 3) results of degradation of organic molecules (biomarkers), that will support the interpretation of missions, such as Rosetta, Exo-Mars and Curiosity). Some priority scientific objectives for the next 10 years are focused on "Life and habitability" and "Biomarkers for detection of extraterrestrial life", what is belonging to the main aims of BIOMEX (Biology- and Mars Experiment, 2014-2016, ESA) [1,3], experiment performed on the exposure platform EXPOSE-R2 on board of ISS. For that reason, samples of the extremophile lichen species *Circinaria gyrosa* as one selected species within the BIOMEX experiment were exposed during 18 months to real space and to a simulated Mars-like environment to study Mars' habitability and resistance to real space conditions. Also the identification of biomarkers was done to include them as reference for future space missions to Mars (ExoMars). After the return of the mission in June 2016, the biological analysis showed a quick and complete recovery of the dark space control samples exposed to space vacuum and Mars-like atmosphere, in contrast to the slow- and lower recovery of the samples directly exposed to space short wavelength UV radiation. This tendency was corroborated with the complementary morphological/ultrastructural analyses applying FESEM and TEM microscopy [3]. Biomolecular analyses (PCR and sequencing) also revealed that the viability of *C. gyrosa* exposed to space conditions decreased in comparison to those exposed to the Mars-like environment [4]. In contrast to these studies, the biogeochemical variations have been examined with Raman spectroscopic analyses to look for possible degradation of cell surfaces and pigments which were in contact with terrestrial rocks, and Martian analogue regolith. Here we present the identification of a biomarker which is called whewellite (calcium oxalate) and other organic compounds and mineral products of the biological activity of the astrobiology model system *Circinaria gyrosa*, detected by Raman Laser Spectroscopy. Samples were exposed to the space- and simulated Mars-like conditions during the EXPOSE-R2 preflight Science Verification Test SVT (2) and the mission parallel ground reference experiment MGR performed at the space- and planetary chambers of DLR-Cologne. These experiments will contribute to the comprehension of the effects of space- and planetary environment on biological systems for future human exploration, as well as deepen our knowledge on the limits, distribution and origin of life.

References

[1] de Vera JP and the BIOMEX-Team (2012) Supporting Mars exploration: BIOMEX in Low Earth Orbit and further astrobiological studies on the Moon using Raman and PanCam technology. *Planetary and Space Science*, 74 (1), Seiten 103-110. Elsevier. DOI:10.1016/j.pss.2012.06.010.

[2] U. Böttger, J. Meessen, J. Martinez-Frias, H.-W. Hübers, F. Rull, F. J. Sánchez, R. de la Torre, J.-P. de Vera. 2013. Raman Spectroscopic Analysis of the Calcium Oxalate Producing Extremotolerant Lichen Circinaria gyrosa. *International Journal of Astrobiology* 00 (2013) 1-14.

[3] de la Torre, R., Miller, A.Z., Cubero, B., Rabbow, E., Meessen, J., Sancho, L.G., de Vera, J.P. 2016. Survival of lichens on the ISS: preliminary results of Circinaria gyrosa as part of the BIOMEX Experiment

[4] Sanchez, F.J., E. Mateo-Martí, J. Raggio, J. Meessen, J. Martinez-Frias, L. G. Sancho, S. Ott and R. de la Torre. The resistance of the lichen Circinaria gyrosa (nom. provis.) towards simulated Mars conditions - a model test for the survival capacity of an eukaryotic extremophyle. *Planetary and Space Science* 72, 102-110 (2012).