EPSC Abstracts
Vol. 6, EPSC-DPS2011-325, 2011
EPSC-DPS Joint Meeting 2011

Preliminary Analysis of Spacesuit Contamination Vectors during a simulated crewed Mars surface expedition

G. Groemer (1), B. Sattler (2) and U. Luger (1) for the Rio Tinto 2011 expedition team
(1) Austrian Space Forum, Innsbruck office (gernot.groemer@oewf.org, Fax: +43-512-507 2923)
(2) University of Innsbruck, Institute of Ecology

Abstract

During a high-fidelity Mars analogue field simulation at the Rio Tinto Mars analogue site in southern Spain between 15-25 April 2011, we have tested potential contamination vectors for a spacesuited astronaut. Using a set of standard geophysical methods likely to be deployed during a Mars mission and the 45kg spacesuit simulator Aouda.X [1], we studied the likelihood of a transfer of simulated biological material between the environment and the human crew.

These potential forward and backward contamination vectors were analyzed using fluorescent microspherules samples during various exploratory activities including utilizing the ESA Eurobot Ground Prototype.

1. Introduction to the Rio Tinto 2011 mission

Mars once had the prerequisite for the development if life, as such, is one of the candidates for finding (diminutive) traces of extinct or extant life. One of the key challenges of such programmes is the management of potential contamination vectors to avoid an unintentional return of biological material back to Earth (“Backward-contamination”) or, which is more likely, an accidental insertion of biological substrates into the Martian environment and as such contaminating the very samples which will be investigated for potential traces of (past) life (“Forward contamination”).

The Austrian Space Forum, in collaboration with scientists from 10 nations including the Center for Astrobiology (INTA/CAB, Madrid) and the European Space Agency, completed a simulated Marsexpedition in the South of Spain (Rio Tinto region, Figure 1)[2]. Due to very unusual heavy rain and wind, not all of the ten planned experiments were performed. The work focussed on the Aouda.X spacesuit simulator, the ESA Eurobot Ground Prototype, medical and astrobiology experiments w.r.t. the contamination vector analysis as well as the Phileas rover prototype. Geophysical investigations and operational tests bringing together the field team and its operations team-on-site (OPS), as well as a dedicated Mission Control Center (MCC/Innsbruck) teams complemented this field mission.

The MCC was comprised of a Flight Control Team, a logistics/media unit and a Remote Science Support team (RSS). This group would solely rely on the field data transmissions from the instruments and OPS and suit telemetry to create a putative geophysical assessment of the site. This data were a-posteriori compared to the ground truth to obtain a measure for the completeness of the data and field methods used.

Figure 1: The Aouda.X spacesuit simulator and the ESA Eurobot Ground Prototype
(Photo: OeWF/P.Santek)

2. Method

The suit simulator and selected equipment elements, such as a powered drill was coated with a well-defined suspension of microspherules and the samples obtained later checked for contamination. [3] For backwards contamination, pre-“contaminated” soil samples were buried on specified spots where the suit tester took shallow subsurface samples with a high likelihood of getting in contact with the prepared soil.

Figure 2: Swabbing test to detect microspherules contaminations on the Aouda.X spacesuit simulator (Photo taken during a training rehearsal, Credit: P. Santek)

We developed a method to trace particulate contamination using fluorescent microspherules as biological proxies, leading to a detailed understanding of the adhesive properties of the microspherules as well as robust statistical methods to determine the detection thresholds and contamination points [4].

On 30 pre-defined spots, the particulate contamination was measured under epifluorescent microscopy in the resonance wavelengths of two different microspherule coatings using a Student-t test to validate the source populations.

3. Preliminary results

Although the data analysis is still in progress, the contamination vector analysis turns out to be a very robust, sensitive and field-suitable tool to monitor biological contamination on a µm-scale.

Our laboratory analysis has shown, that only a fraction (<1%) of the particles remain on the surface coating of the Aouda.X spacesuit simulator, where as the majority of the microspherules was to be found on the hands and legs due to dust transport and equipment handling.

Acknowledgements

The Austrian Space Forum would like to acknowledge the generous support of the Europlanet project, the Center for Astrobiology, Madrid, the Universities of Innsbruck/Austria, Manchester/UK, Vienna/Austria, Budapest/Hungary, Trento/Italy and Sendai/Japan, as well as the European Space Agency (ESA/ESTEC, ESA/EAC), White Label Space and the Austrian Research Promotion Agency.

References

[1] Groemer, G., Hauth, S., Luger, U., Bickert, K., Sattler, B., Hauth, E., Foeger, D., Schildhammer, D., Agerer, C., Ragonig, C., Sams, S., Kaineder, F., Knoflach, M.; The Aouda.X space suit simulator and its applications to astrobiology, Astrobiology, submitted.

[2] Groemer, G.: Rio Tinto 2011 mission report, Austrian Space Forum, 2011, available at www.oewf.org or http://blog.oewf.org/2011/05/rio-tinto-2011-eine-erste-bilanz (accessed 30/05/2011)

[3] Groemer, G.E., Storrie-Lombardi, M. Sattler, B., Hauser, O., Bickert, K., Hauth, E., Hauth, S., Luger, U., Schildhammer, D., Foeger, D., Klauck, J: Reducing biological contamination by a space suited astronaut: Laboratory and field test results from Aouda.X, Acta Astronautica (2010), doi:10.1016/j.actaastro.2010.08.018

[4] Groemer, G.: AustroMars and PolAres: Measuring Forward Contamination During Mars-analogue Missions, Planetary & Space Sciences, Special Issue on Exploring Mars and its Earth Analogues (Ori et al.), Special Issue Planet. Space Sci. (2008), doi:10.1016/j.pss.2008.07.021