In-Situ Biological Decontamination of an Ice Melting Probe

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Abstract –**A major concern in space and even many terrestrial missions is the forward contamination of the alien environment with microbes and biological molecules, transported on spacecraft from Earth. Furthermore, organisms and molecules can be brought to the sampling place from the surface. All this can lead to serious misinterpretations of the obtained data and more importantly, could irreversibly alter the pristine nature of the extraterrestrial environments. These issues were addressed and are constantly updated in COSPAR planetary protection policy (20 October 2002; Amended 24 March 2005; 20 July 2008).**

The objective of our study was to investigate the efficacy of different in-situ decontamination protocols in the conditions of thermo-mechanical ice-melting. We evaluated survival rate of microorganisms on the melting probe as a function of both time and penetration depth. Special focus was made on determination of the optimal concentration of chemical decontaminants (hydrogen peroxide and sodium hypochlorite) the peculiarities of their antimicrobial action at low temperatures (-80 to 0°C) combined with constant dilution with melted ice and mechanical abrasion.

Common, non-pathogenic microbial strains belonging to different morphological and metabolic groups (Pseudomonas, Micrococcus, Escherichia, Bacillus and others) were chosen as test objects for this study. The working part of the melting probe was first controllably contaminated by incubation in suspension of microbial cells. After appropriate sedimentation of microbial cells had been reached, the drilling-melting process was started using specially prepared sterile ice blocks. Every 2 minutes the samples were taken and analyzed. In the control tests, 1 mL of distilled water was injected into the penetration site at the onset of drilling. In the other tests, 1 mL of hydrogen peroxide (30%) or sodium hypochlorite (4%) was used. In addition, the decomposition of biological macromolecules by the applied substances was examined by SDS gel electrophoresis, DNA fragmentation analysis and by means of specialised kits.

Collected data suggest high efficacy of both used compounds in respect of all tested microbial groups. Typically, 99.9% inactivation level was reached within 2-4 minutes after the decontaminant's injection. The obtained results also allowed evaluation of the amount of disinfectant necessary for decontamination of a unit of the probe's surface. At the moment, the two-stage protocol is under development, which would provide even higher killing efficiency by smaller amounts of the disinfecting compounds.