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Possible Consequences of space Mission: Destruction and Survival of Protobiomolecules as organic Contaminants

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Our paper deals with issues related to planetary protection and spacecraft sterilization procedures. Aspects of possible contamination of Mars by terrestrial materials carrying potential external organisms or molecules is of special importance in terms of planetary protection and disaster preparedness. Such space objects as meteorites are the natural carriers of organic substances to the planetary surface. Since the research task was to find out whether major organic substances (amino acids and nucleosides) are able to survive during space flight in the absence of water, one set of experiments was performed onboard MIR space station. During this 113 days flight with apogee 319 and perigee 178 km total irradiation flux was up to $2.4*10^8$ J m^{-2}. That amount of radiation can be achieved during long-term interplanetary flight in diffused medium.

Dry samples of nucleosides and amino acids were exposed on the outer cover of the station. In laboratory simulating experiments, our dry films were exposed to the UVC radiation (145 and 254 nm). Mineral beds of extraterrestrial origin prepared using Allende and Murchison meteorite powder were impregnated with biological molecules and taken to approach the model of meteorite surface. Third mineral, limonite, was taken as material resembling Martian meteorite structure, enriched with biomolecules and exposed in the same experimental conditions.

Data obtained after applying mass spectrometry and chromatography techniques for samples analyzing revealed that the presence of mineral bed stabilized degradation processes occurring within the radiation period and increased the reaction yield both in cases of amino acids and nucleosides. Minerals of extraterrestrial origin such as meteorites Allende, Murchison and lunar soil were tested with respect to their influence

over molecular decay. Further calculation made to extrapolate experimental results to more extended time period showed that organic molecules could possibly survive long - duration exposure to cosmic (145 nm) and Martian (254 nm) UV radiation being protected by mineral shield at least 5 μm thick. These results coincide with our previous experiments performed onboard Bion-11 and Kosmos 2044 space stations. Hence it seems quite plausible that organic molecules are stable enough to survive in severe radiation conditions. The rigorous testing of instrumentation in terrestrial planetary analogue environments prior to the mission is of special importance in order to avoid traces of biological substances to be carried onboard space object into the Martian environment. In case of long-duration space flight, bacterial contaminations would be destroyed by cosmic UVC radiation, while certain biomolecules can withstand aggressive environment on a long run. Therefore, one of the main prerequisite of mission planning should be precise defining of biomolecular contamination on the outer spaceship cover. Since organic molecules are much more resistant than bacteria, future protection policy should be targeted mainly against molecular contamination as the most possible one, while amino acids and nucleosides could be considered as possible contamination biomarkers.