

COMMENTS AND RECOMMENDATIONS CONCERNING AN OPERATIONAL POLICY
WITH RESPECT TO LUNAR AND MARTIAN SPACECRAFT DECONTAMINATION.

During the early phases of lunar exploration the NASA undertook to minimize contamination on Ranger probes in order to avoid depositing terrestrial organisms on the Moon. Even though the objective was complete sterility, as the lunar program advanced it became apparent that such a goal was not then achievable. Nevertheless, the United States probe which impacted on the Moon is believed to have carried only a relatively small number of microorganisms due to the NASA efforts under the policy then in force. The Russian probe which impacted on the Moon is presumed to have carried some microorganisms also. Thus, the Moon now must be considered as no longer uncontaminated by terrestrial life forms. The NASA policy with regard to lunar probe sterilization must take this into account.

Conditions on the lunar surface are sufficiently hostile so that terrestrial organisms could not be expected to proliferate although some might survive in protected places. Knowledge of subsurface conditions is much less certain. The lunar surface with its high temperatures, intense ultraviolet radiation, paucity of moisture, and high vacuum is a most unfavorable environment for proliferation of terrestrial microorganisms. Some forms surely would survive but would be relatively immobile. Except at the site of impact, deep subsurface contamination from a lunar landing appears highly

unlikely. The widespread deposition of contaminants (viable or not) over the lunar surface as a result of impacting of a non-sterile probe seems nearly certain. Therefore, NASA ought not attempt life detection experiments on the Moon's surface but should sample the subsurface (at points removed from any landing site). Meanwhile the unmanned probes which will precede the first Apollo landing need not be completely sterile.

The Rangers should be kept as clean as is feasible so as to minimize contamination. However, procedures which are known to result in serious functional deterioration of certain compounds and are likely to reduce overall reliability should not be applied to these space craft. Thus high temperatures and other treatments which have been shown to result in aging effects ought to be avoided. By appropriate selection of components favoring those which are inherently sterile internally and by the use of chemical sterilants which can decontaminate surfaces it should be possible to hold the levels of contamination approximately the same as prevail in most hospital surgery rooms.

The purpose of avoiding unnecessarily contaminating the moon is to prevent the possible destruction of organic compounds by microbial action and thereby altering the chemical evidence of prebiogenesis of organic constituents. Introduction of organic substances of terrestrial origin into the lunar surface is undesirable but unavoidable. In order to

make possible the interpretation of analytical results from future collections of lunar material an inventory should be kept of all organic chemical constituents on impacting lunar probes.

The above recommendations, if followed, will insure the preservation on the Moon of only the deep subsoil free from contamination by Earth organisms. It is from this subsoil that samples should be collected aseptically and studied for possible biological as well as geochemical interest. Should life exist on the Moon it might be expected at some depth below the surface where temperatures never exceed 100°C and below the zone of ultraviolet radiation. Every effort should be made to keep this level free of possible contaminants until it can be sampled by drilling. Thought should now be given to a drilling system which could be sterilized and return an uncontaminated sample preferably during the early Apollo landings.

The planet Mars is by far the most probable extraterrestrial body in the solar system to be populated with forms of life. The most important possible discovery in Space research would be the finding of extraterrestrial life. Discovery of living organisms on Mars must depend on means of detection which could not be expected to distinguish between terrestrial contaminants and members of an indigenous Martian biota. Some terrestrial microorganisms are known to survive simulated Martian environmental conditions. Therefore the contamination

of Mars through the impacting of non-sterile probes from the Earth would destroy an opportunity to carry out a meaningful search for life forms on Mars. This opportunity is unique and its loss would be an unparalleled catastrophe for science. Therefore it is absolutely essential to preserve Mars until complete sterilization of the probes to land there has been achieved. An augmented research program should be instituted now in which a combined attack by biologists and engineers would tackle this problem. We must not arrive at the time for a Mars landing only to find we have done too little too late.

For these reasons, NASA should accord the highest priority to the prevention of the biological contamination of Mars until sufficient information has been obtained about possible life forms there so that further scientific studies will not be jeopardized.

Moreover, should the initial life detection experiments to be sent to Mars yield negative results, sterilization of Martian probes should not be abandoned automatically. There will remain scientific reasons for continuing to adhere rigidly to a policy of sterilization during the initial phases of sample collection from the Martian surface and subsurface. If sterile, Mars will provide a unique opportunity to detect and analyze organic compounds of non-biological origin in the Martian soil. Such studies of pre-biological geochemistry, free from interference by living organisms, can supply

important and otherwise not directly attainable information concerning the origins of life. Therefore contamination (introduction of viable terrestrial microorganisms) and also pollution (introduction of significant amounts of terrestrial, albeit sterile, organic matter) are to be avoided until adequate soil sampling can be accomplished even if Mars should be found to have no biota.

In order to insure the effectiveness of these actions, the United States should cooperate fully with all other nations in the protection of Mars against premature biological contamination. Exchange of information and perhaps a joint research project between U.S.S.R. and U.S.A. scientists to solve the problem might be suggested. A race to Mars as a matter of national prestige should be avoided. Neither the Russians nor ourselves should be pushed into a race for world acclaim which might destroy the main scientific objective of both nations.

We may succeed in sterilization of Mars probes, but fail because we have not developed the best possible life detection experiments. This is an area which requires a much stronger research program now.