ORGANIC CONTAMINATION PROBLEMS IN THE VIKING
MOLECULAR ANALYSIS EXPERIMENT

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Abstract. The combination of analytical instrumentation selected for the molecular analysis experiment can carry out a survey of the organic compounds present on Mars regardless of their origin. The high sensitivity of this analysis, the limited number of samples which can be analyzed, the close proximity to the landed spacecraft on the surface of Mars which is accessible to the sampling device, the implications of the positive detection of indigenous organic matter in the Martian soil, and our previous experience with meteorites and lunar samples point to the need for a carefully designed program to maintain the integrity of the analyzed Martian surface samples.

A principal problem in interpreting the results of an organic analysis of an extraterrestrial sample is that of distinguishing contaminating material from indigenous material when unknown types and amounts of contaminants make their way into the sample being analyzed. An approach for control of sample integrity in the Viking molecular analysis experiment has been devised which we believe will eliminate such problems. Basically this involves (1) placing an upper limit on the amount of terrestrial contamination that can be tolerated and still allow scientifically meaningful analyses, (2) identifying the potential sources of contamination and analyzing their relative significance, (3) establishing methods to control these sources, and (4) obtaining complete information on the chemical composition of potential contaminants. Our previous experience in the Apollo mission has been of great value in developing the Viking program, perhaps the most important carryover being the recognition of the importance of establishing a comprehensive contamination control program in the early stages of mission planning and hardware design.

The upper limit of total allowable organic contamination has been established as 1 μg g⁻¹. The principal source types, or modes, which contribute to the contamination load have been identified, each requiring a different approach to control. Spacecraft outgassing is controlled by materials selection to minimize outgassing and hermetic sealing whenever possible. Particulate fallout is controlled by selection of materials, particulate seals, cleaning of the spacecraft exterior, and clean room handling. The cleanliness of the direct sample path is controlled by severe materials limitations, ultracleaning, and pressurized sealing of the assembled hardware.

Analysis of the relative probabilities of the sources contributing to the allowable contamination and consideration of the practical aspects of achieving a desired level of control for a particular source has resulted in an allocation 'tree' whereby fractions of the total allowable contamination are distributed to the various individual sources. These efforts have pointed out the need for more information concerning some of these sources and have actually dictated certain design changes in the spacecraft. Additional information was obtained experimentally on descent engine exhaust characteristics which led to the use of an organically cleaner fuel. In summary, the early recognition in the Viking mission of the importance of organic contamination control has allowed the evolution of a complete contamination control program encompassing spacecraft design, mission operations, flight operations, and the design of the science instrumentation for the molecular analysis experiment.

1. Introduction

The molecular analysis experiment has been designed to contribute to the central
theme of the Viking Mission, the search for life on Mars. This experiment has been planned to obtain valuable information about the composition of the Martian surface and atmosphere around a landed spacecraft. The combination of analytical instrumentation selected for the experiment can carry out a survey of the organic compounds present on Mars regardless of their nature. The instrumentation has been described elsewhere in detail (Anderson et al., 1972) and in general involves volatilization and/or pyrolysis of the organic material, fractionation of the volatile and/or pyrolosate compounds by gas chromatography, and identification of the chromatographic effluent by mass spectrometry. The projected sensitivity of the gas chromatograph-mass spectrometer system (GC-MS) is such that identification of $1-10 \text{ ng} \ (10^{-9} \text{ g} - 10^{-8} \text{ g})$ amounts of many organic compounds will be possible. The limitations on size, weight and complexity inherent to spacecraft instrumentation have resulted in a volatilization-pyrolysis oven assembly capable of accepting three separate 60-100 mg surface samples for organic analysis or a total of six samples in the two Viking Landers.

The surface samples to be analyzed for organic content will be collected by a sampling scoop mounted on the end of a furlable boom. This sampling scoop and boom has been designated as the Surface Sample Acquisition Assembly. The surface

![Fig. 1. The Viking Lander sampling area is located on one side of the spacecraft and is accessible by a 3½ m long boom located on the top edge of the lander.](image)