JET PROPULSION LABORATORY INTEROFFICE MEMO

TO M. Elmer FROM G. L. Hobby DATE 11/11/60

SUBJECT Lederberg Life Detection System for Mars Soft Lander (1966)

The proposed overall system can be divided into three subsystems, each capable of independent as well as integrated operation. The essential function of each of the systems will be phase contrast microscopy, microabsorptionspectrophotometry, and growth detection.

System I. Basic System - Phase Contrast Microscopy

A. Functions

1. Collect a sample of dust or soil from the Martian atmosphere or surface.

2. Transport the sample to a device which will prepare it for density fractionation.

3. Fractionate the sample according to particle density.

4. Transport the low density fraction to the stage of a phase contrast microscope.

5. Video observation of sample

B. Specifications

1. Sample Collection

a. The method of sample collection must not be from areas subjected to retro-rocket blasts during the landing.

b. Particle size should be limited to that which is compatible with optimum sample manipulation and microscopic observation.

c. Size of sample must be sufficient to ensure a high probability of obtaining a viable particle.

2. Preparation of sample

Sample should be treated to encourage deadsorption of microorganisms from mineral particles to provide density separation operation.

3. Mass Density Separation

a. Particles having mass densities greater than 1.2 must be separated from particles having densities less than 1.2.

b. Particles in the class of greater density will be discarded; particles of lower density will be retained for observation.

4. Transport System

The refined sample must be transported to the stage of the phase contrast microscope for observation under conditions optimal for phase-contrast microscopy.

5. Video, phase contrast microscope system.

a. The stage of the microscope will require an autofocusing system and horizontal alignment capability.

b. Optical system:

1) Resolution: 0.2 microns (Limited by diffraction) Field size 2, 40μ

2) Magnification: Approx. 1000 diameters

3) Ultra-violet optics

6. Discrimination System

a. Will permit observation of particles having internal structural detail, but not opaque particles or those having homogeneous optical transmission.

b. Will compress data from selected particles to a specified minimum level in order to reduce bandwidth requirements.

System II. Microabsorptionspectrophotometry

The purpose of this experiment will be to obtain absorption spectra of selected particulate material in order to attempt biochemical analysis of the chemical composition.

The experiment will utilize the sample collection, processing, fractionation, transport and vidicon microscope of the basic system. Absorption spectrophotometry will be done on individual particles. This will require that the stage of the microscope be designed to align the selected particle in the optical center of the microscope in preparation for the spectrometric observation.

The monochromator should provide a spectral coverage between 2400 to 8000,A, with a resolution of 10 A. A compromise system would cover 2400 to 4400 with 50 A resolution.

The detection system should be capable of observing eight intensity levels.

System III Growth Experiment

The purpose of this system is to attempt to cultivate and grow microorganisms collected from the soil or atmosphere of Mars.

A. Functions

1. Collect a sample of soil or dust.

2. Sift the gross sample and select particles of a size consistent with optimal functioning of system.

3. Deposit these particles in suitable growth capsules or chambers.

4. Periodically transport the growth chambers to the stage of the microscope for video inspection.

5. Or alternatively, periodically transport the growth capsules to a photometric device for optical density measurements and to pH meter for pH measurements.

B. Specifications

1. Sample Collection

a. The necessity for collecting viable microorganisms makes it necessary to consider the possible effect of retrorocket blasts if these methods are used on the soft lander.

b. If the sample is obtained from the atmosphere of Mars, direct deposition of the solid phase into the growth capsules may be possible. However, if soil samples, containing material in the form or relatively large grains are obtained sifting of the sample may be necessary to obtain particles which may easily be deposited into the capsules.

2. Growth Capsules

a. Growth capsules must be transported periodically to the microscope stage.

b. Several hundred capsules containing different types of growth media will be necessary.

c. The faces of the capsules must be compatible with good optical inspection of the biological samples under the microscope.

d. The capsule material will require a range of optical transmission from 2400 to 8000 Å.

e. Capsules must be designed to prevent excessive evaporation of water from media.

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