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A MANNED EXOBIOLOGY LABORATORY BASED ON THE MOON

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INTRODUCTION

Establishment of an exobiology laboratory on the Moon would provide a unique opportunity for exploration of extraterrestrial materials on a long-term, ongoing basis, for elucidation of exobiological processes and chemical evolution.

A major function of the lunar exobiology laboratory would be to examine samples collected from other planets (e.g., Mars) for the presence of extant or extinct life. By establishing a laboratory on the Moon, preliminary analyses could be conducted away from Earth, thus establishing that extraterrestrial materials are benign before their return to Earth for more extensive investigations.

Unmanned missions to other planets will have a capability for detecting extant life (biology experiments), but less capability for detecting extinct life or for determining the level of prebiotic chemical evolution. Prior to return of samples from another planet to the Earth or lunar laboratory, data from instrumentation on the unmanned missions will be available for analysis. The results from experiments to detect life will be available, as well as data on the organic carbon content of the material to be returned. A spectrum of possibilities then exists concerning these data, from results indicating extant life to data strongly suggesting the absence of significant chemical evolution (e.g., mass spectrometric data indicating the absence of organic carbon).

In the case that extant life is indicated, or that substantial amounts of organic carbon of relatively high molecular weight are found, the return of the sample to a Moon-based laboratory for preliminary study would provide a buffer to terrestrial exposure until the returned samples have been characterized and proven to be nonhazardous. In addition, a wealth of soil samples and cores would be available for study by the laboratory. Immediately at hand would be a wide variety of lunar sample types and amounts as well as meteoritic material; thus, there would be no restriction on sample availability for analysis at the part per billion (ppb) level.

EXPERIMENTS

Initial studies would focus on the search for extant life and would include an array of biological, physical, and chemical studies. If extant life is found in planetary returned samples, the lunar laboratory would perform a variety of investigations to characterize the life form(s) prior to return of the material to laboratories on Earth.

The Moon-based exobiology laboratory would have three major components for study of samples returned from other planets.

1. *The search for extant life.* This component would focus on the detection and identification of life forms using biological, physical, and chemical methods.
2. *The search for extinct life.* This component would concentrate on identification of extinct life using micropaleontological physical and chemical means.
3. *The search for evidence of chemical evolution.* This component would be devoted to the detection and identification of molecules revealing prebiotic chemical evolution. Amino acids/peptides, nucleobases/nucleosides/nucleotides/nucleic acids, and other classes of biologically important molecules would be sought and characterized. This component would also be an important resource in the investigations for extant and extinct life.

INSTRUMENTATION

Although analytical techniques will advance considerably by the date of development of the Moon-based laboratory, the major techniques of chromatographies interfaced with mass spectrometry will be used to separate, identify, and measure the molecules and isotopes of exobiological interest. Miniaturization of these and other analytical instrumentations will provide scientific investigators in the lunar exobiology laboratory with the necessary research tools for identification and structural characterization of organic molecule classes in a wide array of extraterrestrial samples.

BACKGROUND

Our studies (1969-74) of the returned lunar samples (*Gehrke et al.,* 1972, 1975, 1987; *Rash et al.,* 1972) and those of others (*Hamilton and Nagy,* 1972; *Fox et al.,* 1973) have shown the importance of acquiring pristine samples that have not been exposed to terrestrial contamination. Indeed, the question of contamination is continually an important aspect of studies of meteorites or the returned lunar samples, especially with regard to investigations of organic compounds. The establishment of a manned lunar exobiology laboratory, equipped with appropriate instrumentation and a complement of scientists would present a unique scientific opportunity for study of extraterrestrial samples from various sources.

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