ANDROMEDA: A LARGE ENVIRONMENTAL CHAMBER FOR PLANETARY SCIENCE RESEARCH. D. W. G. Sears[1], W. E. Stites[1], T. Kral[2], L. Roe[3], P.H. Benoit[1], S. W. S. McKeever[4], K. Lepper[1], H. Kochan[5] and W. Huebner[6]. Depts [1]Chemistry and Biochemistry, [2]Biological Sciences and [3]Mechanical Engineering, Univ. of Arkansas, Fayetteville, AR 72701. [4]Physics Dept., Oklahoma State Univ., Stillwater, Oklahoma 74078. [5]DLR, Institut für Raumsimulation, D-51147, Kö1n, Germany. [6]Southwest Research Institute, PO Drawer 28510, San Antonio, Texas 78228.

We are constructing a multi-user facility designed to simulate the conditions on the surfaces of planetary objects, namely Mars and volatile-rich (wet/frozen) asteroids or comets. A large (1.2 x 1.2 x 2 meter) vacuum chamber has been donated to the University of Arkansas by the Jet Propulsion Laboratory of Pasadena. The chamber was originally constructed in the early 1980s for simulating processes on the surfaces of comets but more recently was adapted to simulate conditions on the surface of Mars in a project to investigate dust storms. When refurbished at the University of Arkansas, the environmental chamber will be known as "Andromeda" and made available to anyone interested in simulating conditions on planetary surfaces. This will be the largest facility of its kind in North America. A larger facility exists at Cologne [1].

<u>The equipment.</u>

The equipment was delivered in early June 1999 and refurbishment of the laboratory and initial refurbishment of the apparatus will be complete by the end of the year. The chamber will be equipped with pressure and temperature controls that will allow operation down to $\sim10^{-6}$ torr and 77 K, sufficient to simulate the vacuum in space and the low temperatures of Mars and the asteroids. About a cubic meter of planetary soil simulant can be placed in the apparatus. We also plan to install a high-power CO_2 laser that will simulate micrometeorite impacts onto a planetary surface and ten 2.3 kW Xe-lamps that will reproduce the effect of attenuated solar radiation onto the planetary surface. Quadrapole mass spectrometers and gas chromatograph - mass spectrometers will sample the volatiles emitted from the surface. Thermocouples and pyrometers will monitor the temperature of the samples, and the visual appearance of the surface will be recorded with digital television cameras. Several hundred dust collectors will be placed throughout the chamber.

<u>Planned projects.</u>

Wet/frozen asteroid/comet simulation. We will perform simulation experiments in which volatile-rich materials are placed in a vacuum and degassed by heating in a fashion that resembles solar heating due to close solar passage or impact heating [2]. We will examine the size and density sorting that occurs in the non-volatile components and compare the results with metal and silicate proportions in the common meteorite samples [3,4]. Also to be investigated are the strength properties of the surface layers for comparison with laboratory impact experiments [5].

Degradation products of biological molecules. We propose to place biological molecules such as nucleic acids, proteins, lipids, carbohydrates and various mixtures of these molecules at various depths in the martian soil simulant in Andromeda and expose the soil to martian conditions of atmosphere, temperature, pressure, UV exposure and micrometeorite impact for 3-6 month periods. Elevated temperatures may be used in other experiments to speed chemical transformation. At the end of these experiments, we will perform conventional analyses of the soil to determine the nature of the degradation products with a view to looking for such products in returned Mars samples and on Mars using *in situ* methods. In particular, we hope to identify degradation products or degradation profiles distinctive to the Martian environment.

Growth of microorganisms under martian conditions. With the recent discovery that life can exist in extreme environments and that anaerobic microorganisms are central in the "Tree of

Life", it has been proposed that methanogenic microorganisms could survive below the surface of Mars or have been important in the past [6,7]. We propose to place such microorganisms on and throughout the martian soil simulant in Andromeda, monitoring temperature, pressure, gas composition and the production of methane throughout the soil. Test tube experiments have been performed for many years [8], but the chamber will provide a wide variety of microenvironments. The chamber will also provide UV exposure and micrometeorite impact simulation whose effects on these microorganisms are completely unknown.

Inflatable structures for robotic spacecraft. Inflatable structures, communication antennas, solar shields, optical systems, solar concentrators, solar photovoltaic arrays, aerobots, rover tires, and shelters should find a wide range of applications for robotic exploration of Mars [9]. Any final decision on the suitability of various candidate technologies will, of necessity, depend on testing at realistic Martian surface conditions and the chamber will provide such conditions.

Optical dating of martian sediments. Thermoluminescence and optically-stimulated luminescence have been used for many years to determine the age of sediments. We propose to develop miniaturized equipment capable of surviving martian conditions in the simulator that can determine the age of sediments on Mars from space-borne platforms [10].

Summary

We hope that the Andromeda facility will enable new insights into the solar system, its history, the origins of life on Mars and on Earth, and of the future robotic exploration of the solar system. This is an especially exciting time in planetary science research with many nations having major programs to investigate life in extreme environments and into conditions on Mars and the possibility of life on Mars now or in the past. Technological advances and changes in the administration of space missions by these space agencies have meant that a large number of missions will fly in the next decade or so, and that sample return from asteroids, comets and Mars in the near future is a certainty.

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