Mars Ultraviolet Simulation Facility

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Summary. A facility was established for long-duration ultraviolet (UV) radiation exposure of natural and synthetic materials in order to test hypotheses concerning Martian soil chemistry observed by the Viking Mars landers. The system utilized a 2500 watt xenon lamp as the radiation source, with the beam passing through a heat-dissipating water filter before impinging upon an exposure chamber containing the samples to be irradiated. The chamber was designed to allow for continuous tumbling of the samples, maintenance of temperatures below 0°C during exposure, and monitoring of beam intensity. The facility also provided for sample preparation under a variety of atmospheric conditions, in addition to the Mars nominal. As many as 33 sealed sample ampules have been irradiated in a single exposure. Over 100 samples have been irradiated for approximately 100 to 700 h. The facility has performed well in providing continuous UV irradiation of multiple samples for long periods of time under simulated Mars atmospheric and thermal conditions.

Key words: Viking simulation – Martian chemistry – UV irradiation – Mars simulation – Mars photochemistry

Introduction

Results with the biology instruments on the Viking Mars landers indicated that the surface material was very reactive under the experimental conditions employed (Klein, 1977). With few exceptions, the data can be interpreted as being the result of nonbiological reactions of several oxidized species in the Martian soil. These results have spawned an intensive ground-based laboratory effort to aid in interpretation of Viking findings.

One experimental approach that was vigorously pursued consisted of attempts to show that the presumed oxidants could be produced by photo-chemical reactions in simulated Mars atmosphere/surface systems. It soon became apparent, however, that...
data could be better interpreted if simulation experiments were conducted under standardized conditions. As a result, the Viking Project and Planetary Biology Program Offices requested that a Mars UV simulation facility be established at Ames Research Center for use by scientists engaged in Viking data analysis.

The purpose of the facility was to provide a system for long-term UV irradiation of multiple model soil samples under Mars-like environmental conditions. This report describes the development and operation of a Mars UV simulation facility including sample preparation, spectral characteristics of the UV source, and properties of the sample exposure system.

Methods

Sample Preparation

Glassware consisted of a 10-port pyrex vacuum manifold with all-glass greaseless stopcocks (West-Glass W1831-G), two 6-port circular sample manifolds with a stopcock at each port, connected to the vacuum manifold with stainless steel flex tubing and O-ring tube fittings (The Cajon Co.), and two gas reservoirs, 1 and 2 liter capacity. O-ring ball joints (West-Glass 1554,5), 12/30 standard taper ground joints provided with glass hooks for springs, and O-ring tube fittings connecting 1/4 in. (6 mm) OD pyrex tubing were used in fabrication of various components. Apiezon N grease was used conservatively on ground joints and O-rings.

Quartz sample tubes (see Fig. 1) were designed to contain powdered soils in a 50 x 19 mm ampule and be flame-sealed after preparation. Six spacer ‘feet’ extended about 0.5 mm from the ampule wall in order to position the ampule in the center of the rotor tube and allow free gas flow.

Vacuum of $1 \times 10^{-4}$ mm was achieved by a water-cooled oil diffusion pump (CVC PMCS-2C) filled with Convalex-10 pump fluid, backed with a mechanical roughing pump. A trap cooled with liquid nitrogen protected the manifold from back streaming of pump vapors. Pressure was measured with a Bourdon-type mechanical pressure guage (Matheson 63-5601) and an electronic manomenter (Datametrics 1173).

Samples were heated to 160°C in an oil bath or cooled to a specified temperature in the following baths: water ice (0°C), ethylene glycol slush (-10°C), pyridine slush.

![Quartz sample preparation tube](image)