Waters
Lab Highlights
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WATERS GOES TO MARS (AND BEYOND...)

The objective of the gas exchange experiment (GEX) of the Viking mission to Mars was to determine whether biological activity exists in Martian soil. The presence or absence of such activity can be inferred from changes in the gas composition when a sealed sample of dry soil is exposed first to water vapor and then to liquid water containing organic nutrients and inorganic salts.[1] If exposure to the nutrient broth is repeated, biological activity will lead to certain changes in gas composition which continue or increase with time. Chemical and physical changes, on the other hand, should eventually diminish as raw materials in the soil are depleted.

Analysis of gas samples from the soil incubation chamber was performed by gas chromatography on a column packed with Waters PORAPAK® Q porous polymer stationary phase.[2] Operating conditions and a sample chromatogram are shown in Figure 1. Resolution of all components was excellent except for the co-elution of Ar and CO. This caused no problem, since CO abundance was expected to be below the measurement capabilities of the Viking GC.[3] Not indicated in Figure 1 is the capability to elute H_2S at a retention time of about 75 minutes.

Two identical unmanned spacecraft were involved in the Viking mission, and both were launched in 1975. Viking Lander I descended to the plains of Chryse on July 20, 1976, with Lander II reaching the Utopia plains on the opposite side of Mars on September 3 of the same year. The two landers conducted over 100 gas chromatographic separations before their supplies of helium carrier gas were exhausted.[3]

The atmospheric composition was determined to be 96.2% CO_2 with 2.2% N_2, 1.6% Ar and < 0.15% O_2. No evidence of biological activity was found, although the presence of peroxides and superoxides in Martian soil was inferred. Other observed gas composition changes were best explained on the basis of physical and chemical changes.[3]

The advantages of Waters PORAPAK line of GC packing materials were presented in a previous Lab Highlight ("Waters Goes to Venus"). In discussing the Viking project with Dr. G. E. Pollock of NASA's Ames Research Center, it was interesting to discover his enthusiasm for another line of Waters GC products: DURAPAK® GC packings. In upcoming NASA probes to distant planets a DURAPAK GC packing such as Phenyl Isocyanate on PORASIL® C material or a closely related material[4] may be used. The DURAPAK materials are bonded phases with a resulting low bleed of liquid phase. This is essential for work which involves highly sensitive GC

detectors, as will be the case for the upcoming NASA missions. Dr. Pollock suggests that we "beat our own drum" and promote these excellent products. In his experience, superior separations for a wide variety of organic compounds have been obtained using both isothermal runs and temperature programming. In some cases he felt the results to be "as good as capillary GC" due to the exceptional surface area (≃ 400 m^2/g) of the PORASIL C base. Dr. Pollock has had good success with temperatures as high as 120°C provided that the carrier gas was scrupulously scrubbed to remove traces of oxygen. Under normal conditions a maximum temperature of 60°C is recommended.

Based on NASA's enthusiastic support for both PORAPAK and DURAPAK GC packing materials, we should not hesitate to suggest these products to our customers who use GC as well as LC systems.

Vince Warren, Ren Pough

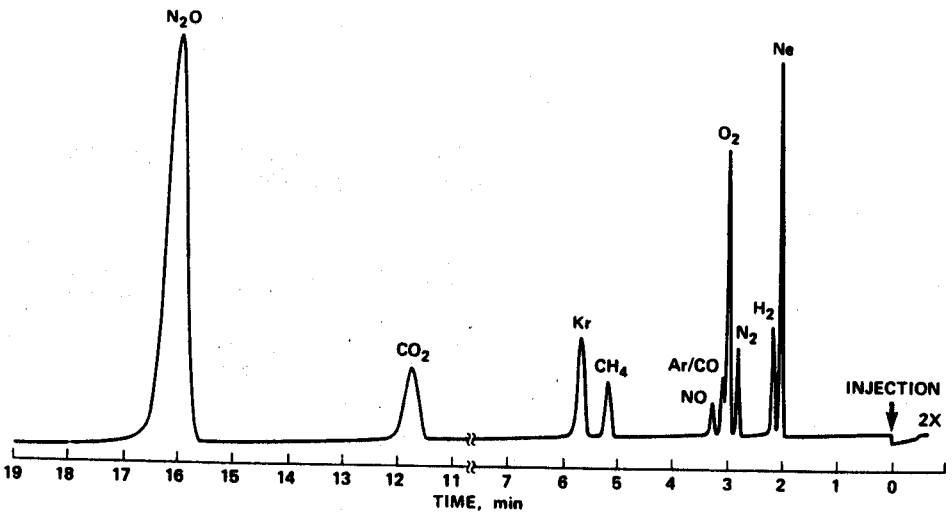

Fig. 2. Viking gas exchange chromatographic separations. Column: Poropak Q 100/120 mesh, 7.6 m × 1 mm i.d. Conditions: Helium carrier gas at 9.3-bar differential, temperature 297 K, flow rate ≈ 15.0 scc min^{-1}.

References:

1. V. I. Oyama, Icarus, 15, 167-184 (1972).
2. V. I. Oyama, B. J. Berdahl, G. C. Carl-, M. E. Lehwalt and H. S. Ginoza, Origins of Life, 7, 313-333 (1976).
3. V. I. Oyama and B. J. Berdahl, J. Geophys. Res. 82, 4669-4676 (1977).
4. G. E. Pollock, D. J. Kojiro and F. H. Woeller, J. Chrom. Sci., 20, 176-181 (1982).