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# When the Viking Missions Discovered Life on the Red Planet

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## Abstract

The first (and only) dedicated life detection experiments on another planet were performed by the Viking Landers of 1976. In the Viking Labeled Release (LR) experiment of Levin and Straat, injections of organic compounds into Martian soil samples caused radioactive gas to evolve approaching plateaus of 10,000 – 15,000 cpm over several sols (Martian days). These "actives" were run at lander sites 1 and 2 with similar results. In contrast, the LR response to the 160$^{o}$ C control sample soils was very low. In conjunction with the active experiment results this negative result from the controls satisfied the pre-mission criteria for life. However, a controversy immediately arose concerning a biologic interpretation of the data. In an attempt to resolve this issue in the current work, we have employed complexity analysis of the Viking LR data for the initial six sols, and of terrestrial LR pilot studies using bacteria-laden, active soil (Biol 5) and sterilized soil (Biol 6).

. Measures of mathematical complexity permitted a deep analysis of signal structure. Martian LR active response data were strongly superimposable upon the terrestrial biological time series, forming a well-defined cluster; and the heat-treated control samples, terrestrial and Martian, also clustered together, but distant from the active group, suggesting that the LR had, indeed, detected biological activity on Mars. The results presente herein are a key subset of the details published earlier by the same authors (IJASS, 13 (1), 14-26, 2012).

## 1. Introduction

For almost 36 years a controversy has raged over whether or not the Viking LR experiment detected Although the results of the LR experiment met the pre-launch criteria for detection of life, the dominant explanation of the results was that a superoxide in the soil was responsible for oxidizing the organic molecules in the LR nutrient. None of the strong oxidants proposed over the years exhibits the thermal profile of the active Martian agent as established by the LR experiments, all being far more heat resistant. Superoxides synthesized in the laboratory [1] as candidates for the LR response turned out to be unstable in aqueous media, breaking down in seconds. The perchlorate discovered in Mars soil [2] similarly fails as a candidate for the LR control response. In contrast, stable LR signals were detected for many weeks after administration of the aqueous nutrient. Furthermore, active samples stored for 3-5 months at 10$^{o}$ C in the dark produced no response. It is difficult to attribute this effect to a strong oxidant or superoxide.

## 2. Materials and Methods

Nine Labeled Release (LR) experiments were performed on Mars soil samples collected with a robotic arm. Each sample (0.5 cc) was injected with 0.115 ml of a solution of formate, glycine, glycolate, D-lactate, L-lactate, D-alanine and L-alanine, each at 2.5 x $10^{-4}$ M, uniformly labeled with $^{14}C$. The samples were then continuously monitored for evolution of $^{14}C$ gas as preliminary evidence of microbial life. L-lactate and D-alanine were included to detect alien metabolism that might require amino acids and sugars with a chirality different from ours. Biol 5 and Biol 6 data were obtained from pre-flight tests conducted in a test standards model of the flight instrument. In these tests, LR nutrient was added to “active” terrestrial soil with a a microbial population (Biol 5), the results of which showed immediate and rapid $^{14}C$-labeled gas evolution, typical of terrestrial soils with high microbial populations, whereas the control sample of the same soil heated to $160^{o}$ C (Biol 6) produced results showing very little gas evolution. Here we present data obtained studying the complexity of the signals (Chaos Data Analyzer) during the first six sols.

## 3. Results

Changes in complexity restricted to the first six sols of four active experiments on Mars, and the first six days on Earth LR tests are herein examined. Figure 1, plots the raw LR data from an active experiment on Mars (VL2c1) and the analogous LR on Earth (Biol 5) together with a physical measure of the temperature.

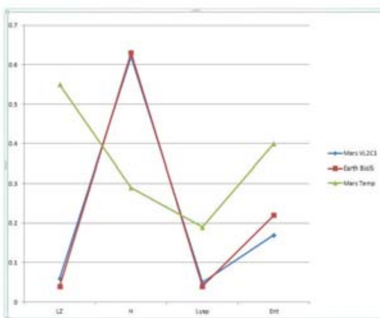

Figure 1: A two-tailed independent t test showing how temperature and radio-labeled gas differ ($p<0.001$), while the complexities of radio-labeled gas on Earth and Mars were superimposable. Temperature did not drive RC fluctuations.

Figure 2 plots the increase or decrease of nonlinear indices after sterilization of soil samples on Mars and on Earth.

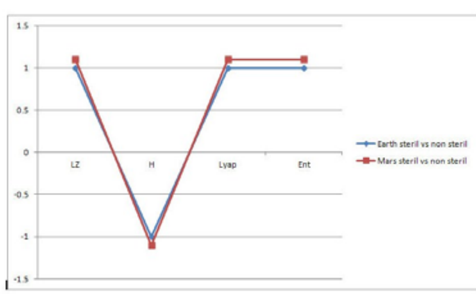


Figure 2: Complexity of radio-labeled gas on Earth or Mars after sterilization showed changes of nonlinear indexes to be superimposable.

Figure 3 plots the data from the 4 active experiments on Mars and Biol 5.

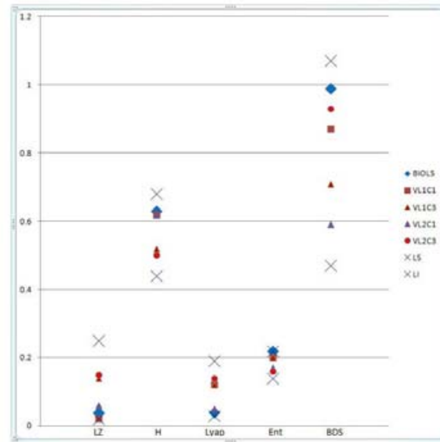


Figure 3: Complexity of radio-labeled gas on Earth or Mars (4 active tests) are seen to be superimposable. X = 2 Standard Deviations (Mars values)

## 4. Summary and conclusions

Nonlinear data of Martian LR active response during the first six sols were deeply superimposable with the terrestrial biological time series. The heat-treated control samples, terrestrial and Martian, fell into a tight cluster, thus suggesting biological activity on Mars. These results are a detail illustrating the complete study presented recently by us [3],which comprised a cluster analysis of the complete data set of negative and positive tests and controls.

## References

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