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There is Life on Mars

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Abstract

An extensive research project that involved the research of multiple major experiments and discoveries about possible life on the planet Mars. Facts, Data, conspiracies and theories have all been taken into account and provided in this project.

Keywords

Mars, Viking Experiment, Methane, ALH8400, Water

Disciplines

Astrophysics and Astronomy

Comments

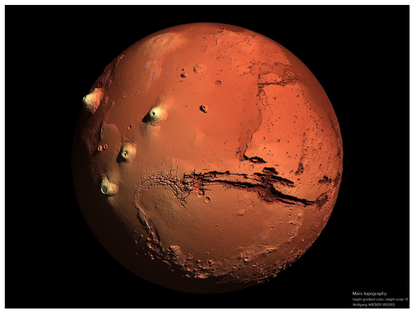
This poster was created based on work completed for FYS 141-3: But Is It Crazy Enough, and presented as a part of the ninth annual CAFE Symposium on February 7, 2024.

There Is Life On Mars

Colin Johnston, Olivier Cohen

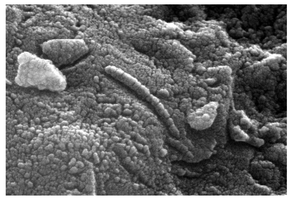
Background

Life existing beyond our Earth has been a fascinating topic for many. NASA has spent billions of dollars on space exploration over the past 60 years and has countless plans in store for the future to try and answer the ever so popular question: is there life on Mars? This topic is an encapsulating one that piques interests from conspiracy theorists, to movie directors, and world-renowned scientists. There are many reasons propelling this intriguing question such as evidence of water, meteorites falling to our Earth, and methane detection. All these discoveries will hopefully be able to reveal the answer to the impossible question: is there is life on Mars?



ALH84001

Allan Hills 84001, or ALH 84001, is a meteorite that fell to Earth and became well-known because of its possible significance for the hunt for alien life. It is thought to have formed on Mars and been expelled from the Martian surface around 16 million years ago. It was discovered in Antarctica in 1984. The contentious assertion that ALH 84001 has tiny structures resembling ancient bacteria-like organisms is what makes it so fascinating. Scientists at NASA's Johnson Space Center, under the direction of David McKay, issued a report in 1996 speculating that these traits could represent proof of extinct life on Mars. The disclosure spurred a heated discussion about the likelihood of life beyond Earth among scientists and the general public. ALH 84001 is contentious largely due to the idea that it includes tiny structures resembling fossilized bacteria-like organisms, which might be proof of previous life on Mars. The question of whether these traits are truly representative of prehistoric Martian life or if non-biological mechanisms can account for them gives rise to dispute. The difficult challenge of differentiating between structures that may be suggestive of life and those that may have been generated by geological or chemical processes is at the center of the controversy.

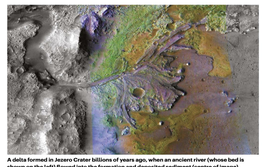


Methane Detection

Methane in the atmosphere of our Earth is biologically produced. Due to this fact, methane detection at the Gale Crater on Mars has certain implications of life. The discovery of spikes of methane at this crater in 2004 has since vanished but there is still methane being detected in other areas of Mars over the years. The detection of higher methane levels over the course of 60 sols—a sol being a day on Mars—indicates a dynamic and maybe seasonal gas release. Although methane may also be produced by non-biological processes, the consistent and erratic character of the emissions begs the issue of where they come from. Researchers are examining several theories, such as the possibility that methane is produced by subterranean microbes or other living creatures. The unsolved mystery surrounding the source highlights the intricacies of Mars' atmospheric processes and geology, prompting scientists to carefully examine the data and explore the possibility that this discovery could be a sign of microbial life or other organic processes on the Martian surface. Using the Sample Analysis at Mars (SAM) instrument called a tunable laser spectrometer (TLS), the detection of methane was undeniable in a distinct pattern of three adjacent lines. Determination of Methane made by the TLS is the difference of measured methane abundance in a sample cell with Mars atmosphere versus the same cell evacuated. A graph on the right explains the results of the TLS-SAM measurements of methane. Methane measurements were generally taken at night, while Mars is a more stable atmosphere, however the two-day time measurements taken shows a significantly less amount of methane detected. This study suggests that there is a variation of methane throughout the day and night which ultimately proves methane is seeping out of the crater from an unknown source. Methane is an unstable molecule, meaning the sunlight will destroy and degrade the gas quickly, suggests that there must be a consistent source in which this methane is coming into the Mars atmosphere.

Water Availability

Mars formerly contained huge volumes of liquid water on its surface, possibly in the form of seas, rivers, and lakes, according to evidence. Ancient lakebeds, deltas, and river valleys are examples of features that strongly suggest Mars was once a wet planet. Water is a basic requirement for life as we know it, and learning about Mars' historical water availability is essential to comprehending the planet's prospective habitability. The possibility that ancient water on Mars might have supported microbial life or other types of life, making it significant. Even though Mars' surface is currently harsh and dry, the exciting potential that life once thrived—or perhaps still exists—in protected underground settings is raised by the idea that liquid water once existed on the planet. Some extremophiles on Earth are adapted to harsh environments, and such species could exist in subterranean aquifers or ice deposits on Mars.



A delta formed in Jezero Crater billions of years ago, when an ancient river (whose bed is shown on the left) flowed into the formation and deposited sediment (centre of image).

Viking Experiment

The Viking mission to Mars were conducted in the year 1975. The Viking mission conducted 3 experiments throughout it's time on the surface of Mars to detect signs of life and look at chemical activity in the soil of Martian soil. The 3 experiments performed were the Gas-exchange experiment, pyrolytic release experiment, and the labeled release experiment.

Gas-Exchange (GeX) Experiment

- Measured changes of the atmosphere over a humidified and moistened regolith (loose, unconsolidated rock) sample.
- Measured gases such as: H_2, N_2, O_2, CO, NO, CH_4, CO_2, N_2O, and H_2S.
- Slow decreases of O_2 and CO_2 were observed over multiple sols.
- No other changes in these gases were observed after the wet period with nutrients.
- No life signals detected

Pyrolytic Release (PR) Experiment

- Tested possibility that possible Martian microorganisms could take up CO_2 and CO gases during light and dark reactions.
- After incubation soil was baked and detected for gases that contains evidence of microorganisms in the soil.
- CO_2 and CO gases were found very low in the Martian regolith yet still significant at 7 pmole of CO and 26 pmole of CO_2.
- These results could have biological interpretations to it.
- No Life Signals Detected

Labeled Release (LR) Experiment

- Most successful of the three Viking experiments
- Measured evolved CO_2 gas given off by carbon labeled carbohydrates reacting with Martian regolith due to microbial metabolism.
- After collecting samples, the samples were "spiked" with organic nutrients which included amino acids.
- Observed that there are similar conditions in these soil samples as what you'd expect on present Earth life.
- Radioactivity in the carbon labeled nutrient solution increased as shown in the graphs.
- Many scientists conclude the released CO_2 could have stemmed from inorganic reactions from chemically reactive soil.
- Today, many scientists can say confidently that organic compounds do exist on Mars.
- Martian microorganisms may contain strong oxidants that react with organic compounds to produce CO_2.
- This experiment concluding that there's organic compounds as well as evidence of water is the most compelling theory of life on Mars today.

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Graphs and Illustrations

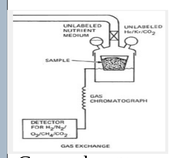
Table 1. Curiosity TLS-SAM methane measurements at Gale crater (4.5°S, 137.4°E) over a 20-month period. L_s, solar longitude. CI values are ±2 SEM for individual results and are explained in the supplementary materials (32) for the grouped results in the last three rows.

Martian sol after landing 6 Aug 2012	Earth date	L_s (degrees)	Gas ingest time/cell pressure (mbar)/foreoptics pressure (mbar)	Mean value ± 1 SEM (ppbv)	Mean value ± 95% CI (ppbv)
79	25 Oct 2012	195.0	Night/8.0/11.5	−0.51 ± 2.83	−0.51 ± 5.66
81	27 Oct 2012	196.2	Night/8.0/11.5	1.43 ± 2.47	1.43 ± 4.94
106	27 Nov 2012	214.9	Night/8.5/10.9	0.68 ± 2.15	0.68 ± 4.30
292	1 Jun 2013	328.6	Night/8.7/9.2	0.56 ± 2.13	0.56 ± 4.26
306	16 Jun 2013	336.5	Day/8.1/0.0	5.78 ± 2.27	5.78 ± 4.54
313	23 Jun 2013	340.5	Night/8.7/0.0	2.13 ± 2.02	2.13 ± 4.04
466	29 Nov 2013	55.7	Night/8.0/2.3	5.48 ± 2.19	5.48 ± 4.38
474	6 Dec 2013	60.6	Night/79/2.3	6.88 ± 2.11	6.88 ± 4.22
504	6 Jan 2014	72.7	Night/8.1/2.3	6.91 ± 1.84	6.91 ± 3.68
526	28 Jan 2014	81.7	Day/75/2.3	9.34 ± 2.16	9.34 ± 4.32
573	17 Mar 2014	103.4	Night/5.3/2.3	0.47 ± 0.11	0.47 ± 0.22
684	9 Jul 2014	158.8	Night/4.5/2.7	0.90 ± 0.16	0.90 ± 0.32
684	9 Jul 2014	158.8	Night/6.8/2.7	0.99 ± 2.08	0.99 ± 4.16
Mean value of low-methane sols 79, 81, 106, 292, 313, 684				0.89 ± 0.70	0.89 ± 1.96
Mean value of low-methane enrichment results for sols 573 and 684				0.69 ± 0.09	0.69 ± 0.25
Mean value of high-methane sols 466, 474, 504, 526				7.19 ± 0.74	7.19 ± 2.06

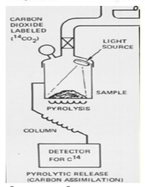
High methane values detected on sol 466, 474, 504, 526. note daytime value of sol 306.

Table 3 Gas composition (corrected) in gas exchange test cell (humid mode)

	Time from humidification (h)				
	2.78	27.86	52.51	101.91	150.74
	Sol 9	Sol 10	Mars Date Sol 11	Sol 13	Sol 15
Gas	Quantity of gas* (nmol)				
N_2	73	76	83	79	77
O_2	500	650	690	690	690
CO_2	5,900	8,300	9,500	9,800	9,400
Ar†	8	7	13	9	8
Ne‡	20	19	18	20	21
Kr§	2,000	2,000	2,000	2,000	2,000



Gas-exchange apparatus



Pyrolytic release apparatus

Table 3. Pyrolytic release counting rates and their standard errors.

Experiment	Counts per minute			
	Total	Background	Net	Expected
		Peak 1		
1 (active)	7899 ± 59	478 ± 0.62	7421 ± 59	
2 (control)	8129 ± 60	480 ± 0.57	7649 ± 60	
		Peak 2		
1 (active)	573 ± 0.83	477 ± 0.79	96 ± 1.15	≤15
2 (control)	500 ± 0.47	485 ± 1.20	15 ± 1.29	≤15

Radioactivity of CO_2 detected during pyrolytic release experiment. A small, but significant formation of organic matter occurred in Exp.1

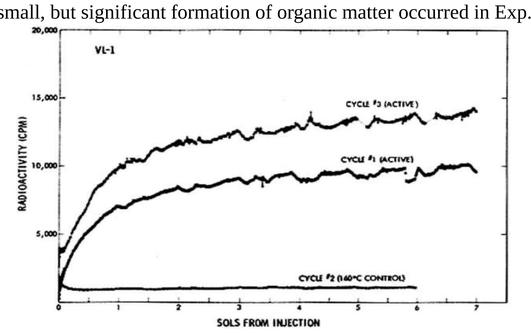


Fig. 1 Viking Lander 1 (VL-1) LR data. Soil in cycle #2 was heat-sterilized for 3 hrs at 160°C before initiating the LR assay (from Levin and Straat 1977)

Conclusion

In the relentless pursuit of unraveling the mystery of life on Mars, decades of scientific exploration, exemplified by endeavors like the Viking Experiments and the study of the Martian meteorite ALH84001, have yielded intriguing yet inconclusive evidence. The detection of methane at the Gale Crater and the acknowledgment of water, both historical and present, add layers to this captivating narrative. While each revelation stirs speculation and debate, the question of Martian habitability remains elusive. The journey to determine the existence of life on Mars encompasses a dynamic interplay of scientific discoveries, skepticism, and international collaboration, fueling an enduring quest for answers beyond Earth.