

LIFE ON MARS – DAWN OF A NEW AGE

***“It is now more difficult to propose
a sterile Mars than a live one”***

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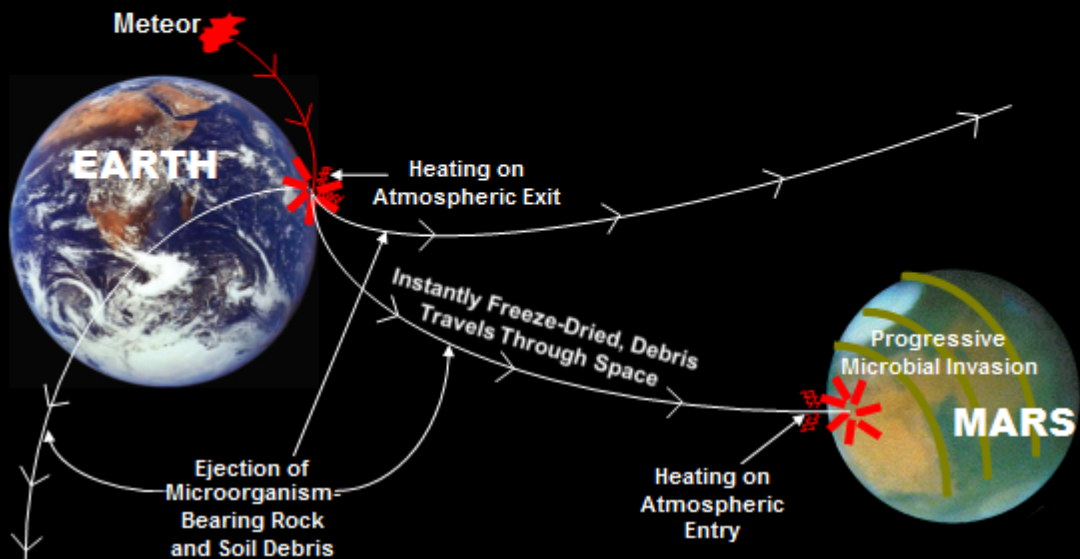
ABSTRACT

Some 35 recent scientific papers lend support to the possibility of life on Mars. Many also address the likelihood of transfer of microorganisms from one planet to another by meteoric impact. Extremophiles have been found that could survive. The author presents a model of Panspermia consistent with these findings, depicting each of the steps necessary to infect Mars with terrestrial organisms. Examination of the papers cited strengthens each link in the proposed chain of life bringing Mars within our biosphere. This evidence that terrestrial microorganisms could migrate to Mars and survive demonstrates the likelihood that life, from Earth or other sources, exists on Mars today. **It is now more difficult to propose a sterile Mars than a live one.**

Evidence refuting the traditionally cited key arguments against a biological interpretation of the 1976 Viking Labeled Release (LR) life detection experiment on Mars is given, including a first-time demonstration of liquid water under Martian conditions. Together with herein newly revealed evidence virtually precluding a highly oxidizing surface on Mars, these new findings add impetus to the increasing acceptance of microorganisms as the source of the Viking LR positive response. In response to requests from scientists showing new interest in the Viking LR results, NASA will soon launch and maintain a web site to host all of the LR data to permit new types of analyses.

As a possible means for settling the issue of extant life on Mars, a miniaturized LR experiment, modified to distinguish between chemical and biological reactions, is proposed for the next Mars lander. It is based on the widely accepted fact that chemical reactants do not distinguish between the stereoisomers of a given optically active amino acid or carbohydrate, while all known forms of life do. L- and D- isomers of ^{14}C -labeled amino acids and carbohydrates would be separately added to duplicate samples of Martian soil. A preferential response to one isomer over the other would constitute unambiguous evidence for life. Preferences for L-amino acids and D-carbohydrates would indicate a similarity for Martian and terrestrial life forms, while the opposite set of preferences would indicate independent origins of the two biological systems.

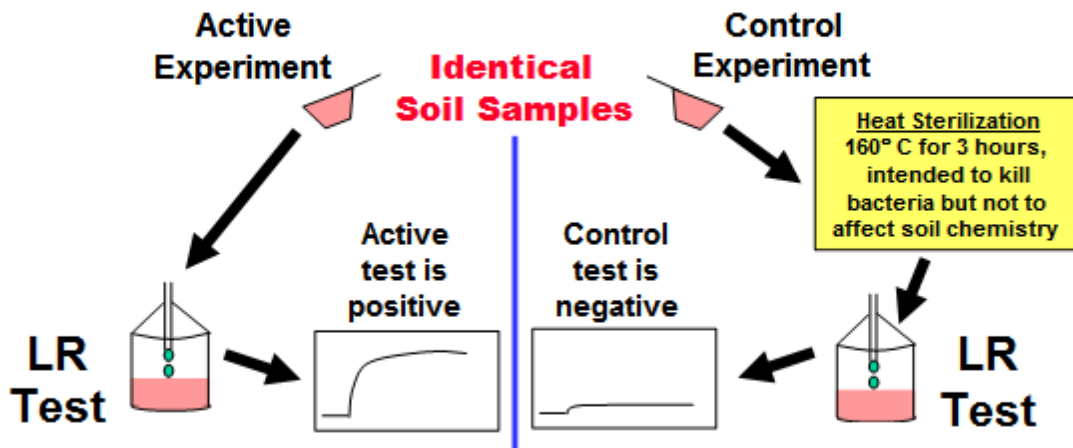
How Earth Infects Mars



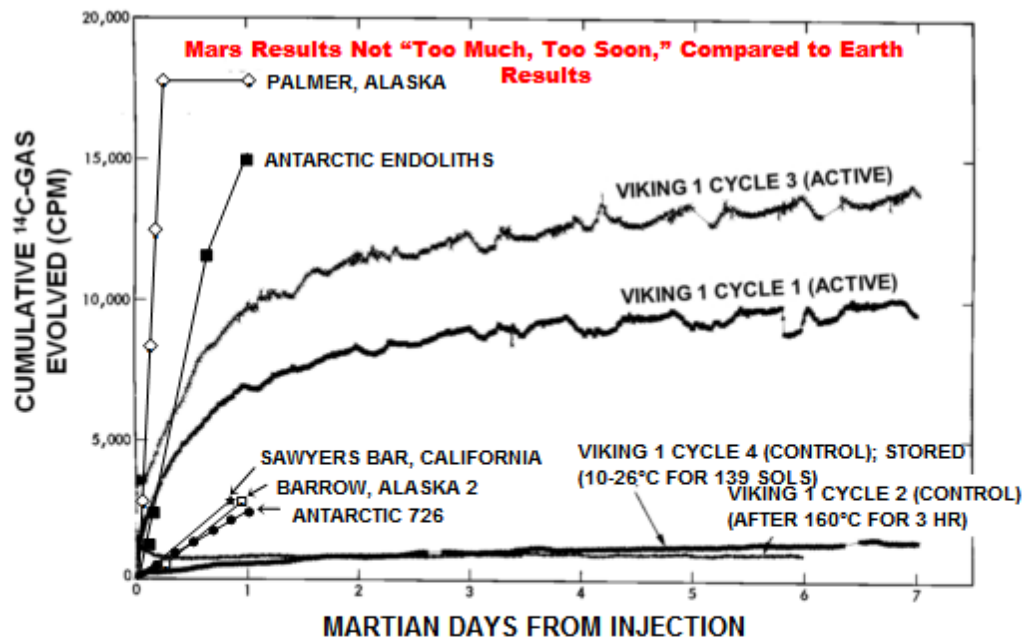
Microorganisms in debris ejected by meteor impact on Earth survive shock and atmospheric heating, and are immediately freeze-dried by space environment. Organisms at UV- and ionizing radiation-protected depth survive. Some debris is captured by Mars' gravity, heats and ablates entering atmosphere, but interior microorganisms survive. They survive impact that distributes them over wide area. Finding environment favorable, they establish habitat and invade Mars, *as could organisms from other sources.*

The Viking Labeled Release Life Detection Experiment

That Detected Life on Mars in 1976



Mars and Terrestrial LR Soil Tests Show Metabolism



Note: LR monitored continuously on Mars, terrestrial tests only where points indicate.

Theories Put Forth to Refute Mars LR Evidence for Life

Oxidant Theories

1. Hydrogen peroxide formed in atmosphere
2. Hydrogen peroxide formed on rocks
3. Hydrogen peroxide catalyzed by gamma iron
4. Hydrogen peroxide formed on titanium dioxide
5. Potassium dioxide in soil
6. Zinc dioxide in soil
7. Manganese dioxide in soil
8. Oxygen plasma
9. Superoxides in soil
10. Peroxynitrate in soil
11. Polymeric suboxides in soil
12. Iron VI production of oxygen radicals

Other Theories

13. No liquid water on surface of Mars
14. LR response was "Too much too soon"
15. No organics found in Mars soil
16. UV irradiation destroys organics and life
17. Ionizing radiation activates minerals to react with LR nutrient
18. Ionizing radiation on oxygen-rich minerals produces disjunctions
19. Carbon dioxide trapped in micropores of soil
20. Activated halides in soil
21. Mineral catalysis of LR medium
22. Mineral catalysis of formate
23. Heat of solution from nutrient wetting desiccated minerals
24. Iron III decarbonylation of lactate
25. Smectite clays
26. Palagonite clays
27. Limonite clay
28. Statistical improbability of independent origin of life

***None has Adequately Explained or
Reproduced the Mars LR Data***

Demonstration that Liquid Water Forms on the Surface of Mars Supports Life Possibility

Frost on Mars (remained for about 100 Martian days)



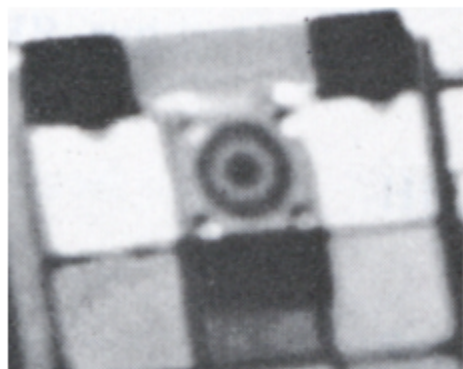
Mars in a Jar: Liquid Water from Frost on Rock



Be Where the Oxides of Mars? Death of a Fable

BREAKING NEWS!

All Oxidant Theories Bite the Dust in the Viking Magnetic Properties Experiment



Reference test chart magnet
image for VL-1 on sol 31.



Reference test chart magnet
image for VL-2 on sol 42.

In newly examining the Viking data, the author found strong evidence, apparently long overlooked, against a highly oxidizing surface on Mars. Providing rationale for his magnetic properties experiment on Viking, Robert Hargraves said, "...if there is a lot of material adhering to the magnet, it would certainly say that whatever the surface processes are on Mars, they are not innately highly oxidizing." After analyzing his Viking results, Hargraves reported, "...the loose Martian surface material contains 1 to 7% highly magnetic mineral." The magnets picked up layers of 2 to 4 mm of material (see above) including "highly magnetic, unoxidized mineral grains." **This large amount of magnetic material precludes all oxidant theories.**

L'Envoi, En Fin!

“Organic Matter in SNC Meteorites: Is it Time to Re-Evaluate the Viking Biology Data?”

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EXCERPTS

“The two Viking landers, which set down on Mars in 1976 have been the only craft to date to carry experiments designed for the direct search for microorganisms. The Labeled Release Experiment (LR) results with respect to life forms were positive based on criteria established before launch. However, largely in light of the failure of a fourth instrument, a mass spectrometer-gas chromatograph (GC-MS), to detect organic matter, the LR responses were later interpreted to have been produced by inorganic chemical oxidants presumed to exist in the Martian regolith.

More recently, evidence has begun to grow supporting the possibility that the Viking GC-MS would not have detected certain carboxylate salts that could have been present as metastable oxidation products of high molecular weight organic species. Additionally, despite the instrument's high sensitivity, the possibility had remained that very low levels of organic matter, below the instrument's detection limit, could have been present. Such low levels of organic matter would not be inconsistent with the presence of very low levels of microorganisms.

Since the strength of the GC-MS findings was considered enough to dismiss the biology packet, particularly the LR results, any subsequent evidence suggesting that organic molecules may in fact be present on the Martian surface necessitates a re-evaluation of the Viking LR data.

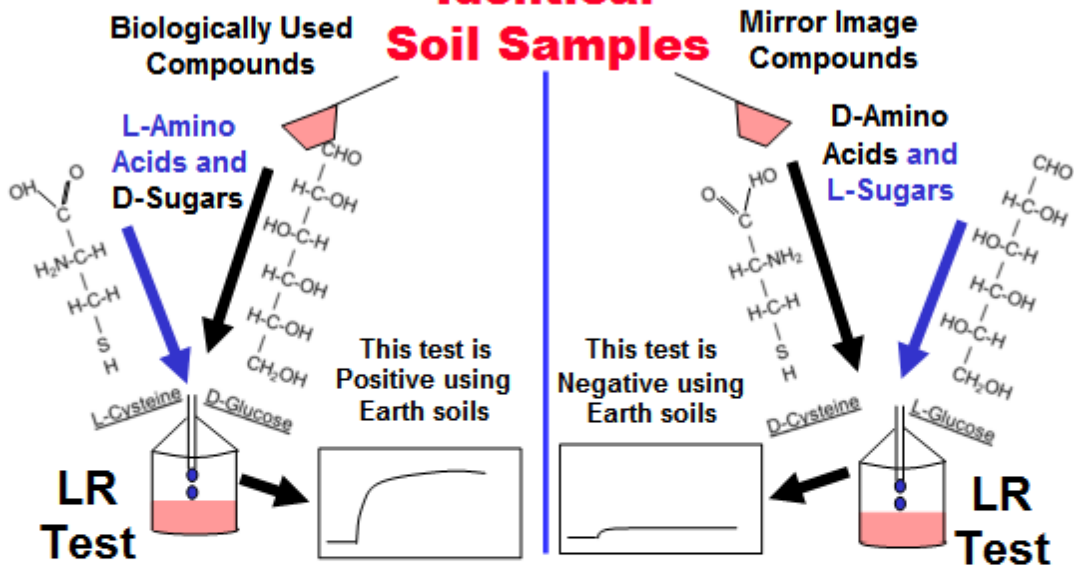
Given this perspective on organic material, a biological interpretation of the Viking LR results can no longer be ruled out.

Since the time of Viking, studies have been carried out with the objective of determining an oxidant, or combination of oxidants, that might exist on Mars and have produced the observed kinetics of the LR response. **To date, no such agent has been found that produces all aspects of the LR results on Mars ...** it is concluded that inorganic and biological explanations for the Viking LR data should now be considered equally plausible.”

A New Experiment Could Unambiguously Resolve the Life on Mars Issue

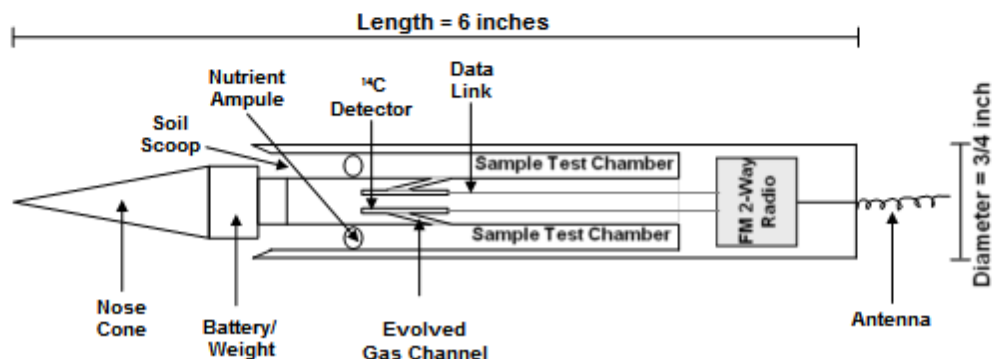
Chiral LR Experiment

Identical Soil Samples



A Chiral Preference Demonstrates Life

Chiral LR Probe



Note: Pre-sterilized canister contains multiple probes that are ejected away from spacecraft after landing.

All Links in the Vital Chain Connecting Mars and Earth Are Now Established

1. Microorganisms are widely distributed on Earth.
2. Meteorites impacting Earth eject soil and rocks into space.
3. Microorganisms in the ejecta can survive the shock and temperature of impact.
4. Microorganisms in ejecta can survive heating through Earth's atmosphere.
5. Microbes can survive the temperature and vacuum of the space environment.
6. Microorganisms can survive the ionizing radiation of space.
7. Mars-infecting ejectus can approach Mars and be captured in its gravity well.
8. Microbes can survive the temperature of entering the Martian atmosphere.
9. Microbes can survive the shock and temperature of impact on Mars.
10. Terrestrial microorganisms can grow under Martian conditions.
11. Microorganisms are capable of adapting to or evolving to spread over wide regions of Mars.
12. Earth and Mars were hospitable over epochs that would have permitted infection of Mars by Earth microorganisms—and from other sources.

Biology offers the only fit to the LR Mars data and is consistent with our new knowledge about Mars and Earth.

It is time to accept the LR Results.

It is now more difficult to propose a sterile Mars than a live one.

Earth and Mars are part of the same biosphere.

See <www.spherix.com/Mars>

New Reports Consistent with or Supporting Biological Interpretation of Mars LR Experiment

Impetus For A Changing Mindset

"Inorganic and biological explanations for the Viking LR data should now be considered equally plausible ..." D. Warmflash et al., *Proceedings of the 32nd Lunar and Planetary Science Conference*, March 12-16, 2001.

Panspermia re-surfaces, can transport life between planets, J. Melosh, *Proceedings of the 32nd Lunar and Planetary Science Conference*, March 12-16, 2001.

Conservative calculations find probability of interplanetary transport of viable microorganisms small, but not negligible, B.C. Clark, *Origins of Life and Evolution of the Biosphere*, 31, 185-197, 2001.

"Truncated hexa-octahedral magnetite crystals in ALH84001: Presumptive biosignatures," K. Thomas-Keprta et al., *Proc. Natl. Acad. Sci. USA*, Vol. 98, Issue 5, 2164-2169, February 27, 2001.

"Chains of magnetite crystals in the meteorite ALH84001: Evidence of biological origin," E. Friedmann et al., *Proc. Natl. Acad. Sci. USA*, Vol. 98, Issue 5, 2176-2181, February 27, 2001.

"Use of spacecraft data to derive regions on Mars where liquid water would be stable," B. Lobitz et al., *Proc. Natl. Acad. Sci. USA*, Vol. 98, Issue 5, 2132-2137, February 27, 2001.

GCMS could not have detected bacteria even if several million cells per gram were in Martian soil, D. Glavin et al., *Earth and Planetary Sciences*, 185, 1-5, 2001.

Space-borne primal chemical soup "can easily trigger life," M. Bernstein et al., *Scientific American*, 7/99, co-author L. Allamandola quote from *Washington Post* interview, 1/30/2001.

"Bacterial spores may survive an impact-induced escape process in ... interplanetary transfer of life," G. Horneck et al., *Icarus*, 149, 1, 1/23/01.

Discoveries about life on Earth inspire Beagle 2, F. Westall et al., *Planetary and Space Science*, 48, 181-202, 2000, reported in *sci.esa.int*, 12/15/00.

"A Dripping Wet Early Mars Emerging from New Pictures," R.A. Kerr, *Science*, 290, 1879-1880, 2000.

"Evidence for Recent Groundwater Seepage and Surface Runoff on Mars," M.C. Malin and K.S. Edgett, *Science*, 288, 2330-2335, 2000.

New Reports Consistent with or Supporting Biological Interpretation of Mars LR Experiment (continued)

Bacterial "fingerprint" in Leonid Meteor train, C. Wickramasinghe, *Cardiff Centre for Astrobiol.*, 11/00.

Viable transfer of microbes, if they exist on Mars, is **highly probable**. Earth to Mars transfer was also found possible. Five billion rocks capable of bearing radiation-surviving microbes likely arrived on Earth from Mars over the past 4 billion years., C. Mileikowsky *et al.*, *Icarus*, 146, 2, 391-427, 2000.

"The duration and extensive locations where these **liquid water films can exist on Mars**," R. Quinn *et al.*, Session 62, Mars Surface and Satellites II, NASA DPS Pasadena Meeting, 10/27/00.

"**Recent surface seepage of water...**" A. Zent *et al.*, Session 62, Mars Surface and Satellites II, NASA DPS Pasadena Meeting, 10/27/00.

"**Living organisms could emigrate through the solar system ... launch, space transit and re-entry are not too harsh**" B. Weiss *et al.*, *Science*, 290, 791-795, 10/27/00.

Microbes grow at South Pole (with access to liquid water similar to that on Mars), **withstand extreme dryness and large doses of radiation**, E. Carpenter *et al.*, *Applied and Environmental Microbiol.*, 66, 10, 4514-4517, 10/00.

Bacteria 250 million years old trapped in salt crystals revived, "could move from planet to planet," R. Vreeland, *Nature*, 407, 897-900, 10/00.

Salt-loving bug sequenced, might be **case for life on Mars**, W. Ng *et al.*, *Proceedings of the National Academy of Sciences*, 2000, S. DasSarma, co-author, quoted in BBC News 10/2/00.

"Bacteria live and grow in clouds ... **survive sub-zero temperatures, intense ultra violet radiation and limited nutrients.**" - B. Sattler *et al.*, *Geophysical Research Letters*, 28, 2, 2001, quoted in *New Scientist Magazine*, www.newscientist.com, 8/24/00.

Microorganisms metabolize and reproduce in ancient permafrost soil, reversing strong opinion that absence of liquid water precludes life on Mars, E. Rivkina *et al.*, *Applied and Environmental Microbiol.*, 66, 8, 3230, 8/00.

Microbial life beneath high arctic glacier, M. Skidmore *et al.*, *Applied and Environmental Microbiol.*, 66, 8, 3214-3220, 8/00.

New Reports Consistent with or Supporting Biological Interpretation of Mars LR Experiment (concluded)

Experimental evidence for liquid water under Martian conditions; LR Mars response consistent with responses from terrestrial soils; Viking GCMS could have missed organics in moderately or low-populated soils, G. Levin, L. Kuznetz, and A. Lafleur, *Proc. SPIE*, Vol. 4137, 48-62, 2000.

"Microorganisms grown under some of the conditions found on Mars ... grew better with limited water." No organic matter was supplied, T. Kral *et al.*, *Proc. 100th General Meeting of the American Society for Microbiology*, 5/00.

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Large Mars rock may be biological stromatolite, built by microorganisms, possibly cyanobacteria, M. Russell *et al.*, *J. Geol. Soc. London*, 156, 5, 869-888, 1999.

"Earth microbes on the moon," common bacteria left on the moon by Surveyor 3 were **revived after two-and-a-half years in the dry, cold vacuum**, R. Hoover *et al.*, *Space Science News*, 9/1/98.

Up to 90% of Earth microorganisms in ejecta would survive a 1,000,000 year trip to Mars, C. Mileikowsky, *Founding Convention of the Mars Society*, U. Colorado, Boulder, CO, 8/16/98.

Bacteria on rifle bullet survived impact of 100,000 g, yeast survived 70,000 g, thus **could survive impact of planetary transfer,** C-A Roten, *Founding Convention of the Mars Society*, U. Colorado, Boulder, CO, 8/16/98.

A model for available liquid water on the surface of Mars; chiral LR experiment recommended to resolve Mars life issue, G.V. Levin and R.L. Levin, *Proc. SPIE*, Vol. 3411, 30-41, 1998.

High-resolution spectroscopy of Mars finds no H₂O₂ in Martian atmosphere," V. Krasnopolsky *et al.*, *J. Geophys. Res.*, 102, No. E3, 6525-6534, 1997 (confirms findings of Mariner 9 IRIS experiment [G.V. Levin and P.A. Straat, *Icarus*, 45, 494-516, 1981]).

First claim that Viking LR detected microbial life on surface of Mars, proposes confirmation by chiral LR experiment, G.V. Levin, *Proc. SPIE*, Vol. 3111, 146-161, 1997.

Possible Evolution of the Solar System's Genome

