

## The Curiousness of Curiosity

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CURIOSITY HAS REACHED the base of Mount Sharp, its promised land, the land where I hope it will at last perform its promised key analyses. Until now, Curiosity has been primarily an engineering mission, demonstrating an amazing landing technique and showing it can drive around the planet. The analyses reported allow NASA to state that the mission has achieved its “primary goal” of determining that Mars was once habitable. However, the science output has been limited and scarce. For more than two years on the Red Planet, Curiosity has unaccountably deferred performing analyses that are most directly concerned with evidence for life: the liquid extraction assay for organic compounds and the high-resolution imaging of green spots or areas Curiosity has shown on many of the nearby rocks.

Requesting extension of their mission, Curiosity scientists proposed continuing its present program. In reviewing this request, NASA’s 2014 Planetary Mission Senior Review panel highlighted this paucity in the mission’s scientific productivity in its report published September 3, 2014. This panel of nationally known planetary science experts found “problems with the proposal were sufficiently severe they need addressing at the earliest opportunity.” The panel criticized that “only eight drilling samples are planned to be taken during the two year extended mission, that the panel considered a poor science return for such a large investment.” Further, the report stated, “The proposal lacked specific scientific questions and testable hypotheses.”

I believe these same comments apply to the two plus years of work already completed by Curiosity.

NASA has repeatedly stated that Curiosity carries no life-detection capability. This seems a very curious omission to me in that NASA has continuously stated that one of its prime objectives is to determine whether Mars had or has life. Prior to the launch of Viking, the agency stated that the search for life on Mars might be the greatest experiment in the history of science. Yet, despite the positive results from the Viking Labeled Release (LR) life-detection experiment in 1976, no life-detection experiment has ever since been sent to Mars. The claim that the Viking LR detected life, made by me and my Viking Co-Experimenter, Dr. Patricia A. Straat, remains disputed. Its results should certainly have been immediately queried by subsequent Mars probes. Even were the strong LR responses caused by chemistry, not life, they are an extraordinary finding that demands further in-

vestigation. Unfortunately, there was no clamor from the scientific community, and this omission will continue on the new Mars lander, tenuously planned for 2020.

Following NASA’s no-life-detection statement about Curiosity, I published an article (“Stealth Life Detection Instruments Aboard Curiosity,” *Proc. SPIE* 8521, Instruments, Methods, and Missions for Astrobiology XV, 852102, October 15, 2012, doi:10.1117/12.928032) addressing those Curiosity experiments I thought could confirm that the Viking LR experiment did detect life. Those experiments are the liquid extraction assay for complex organics (essential to support the claim for life) and use of the Mars Hand Lens Imager high-resolution camera for up-close inspection of some of the green spots shown on rocks in many of the large-scale images downloaded from Curiosity. The Mars Hand Lens Imager has a resolution of a fraction of the diameter of a human hair and therefore might reveal morphology indicative of biology. I made two predictions, as follows: (1) Curiosity would detect complex organic compounds and (2) Curiosity would confirm the presence of current liquid water (which it has since done). Neither the article nor my direct appeals to Curiosity scientists drew any comment or action on the organic and imaging issues.

Thinking that these experiments might have been run, but not yet reported, I submitted an FOIA to NASA requesting them. The response came January 14, 2014, stating,

For part one of your request, I could not locate any responsive Government records. Please be advised that the liquid extraction protocol of SAM has not yet been used on Mars. The methods that will be used for this liquid extraction are fully described in the attached open literature. For part two of your request, please be advised that all of the raw MAHLI images are released to the public on the JPL web site,

and was signed by the Freedom of Information Act Public Liaison Officer, Records Manager.

Scrutiny of published images by colleagues and myself has found no close-ups of the green spots on the rocks capable of showing possible biological patterns.

The vitality (pun intended) of the Viking LR remains. No experiments are yet planned to test it. The statement at the Viking exhibit in the Smithsonian also remains: “Biological experiments on the Viking Landers did not detect signs of life.” To say there were no signs of life is woefully incorrect. Basically, there are three types of evidence: consistent,

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definitive, and compelling, in increasing order of certainty. Not only are the data from the Viking LR consistent with life, nothing we have learned about Mars is inconsistent with life. Terrestrial microorganisms have been grown under conditions as severe as on Mars, even surviving in naked space on the exterior of the International Space Station. Laboratory simulations have produced evidence that terrestrial ejecta produced by meteoric impact could arrive on Mars and deposit an infectious load of microorganisms. Indeed, it would now be surprising if life were not on Mars. As to being definitive, the strong Viking LR positive and control results would certainly be definitive on Earth. Such evidence, even minus any controls, was deemed compelling by public health authorities that relied on it daily for many decades in testing food and water. Yet scientific authorities question or reject the Viking LR claim to life. This doubt remains despite the failure of all published attempts to attribute the Viking LR results to chemistry, including a recent publication stating that galactic cosmic rays and solar energetic particles transform perchlorate in the martian soil into a compound that was responsible

for those results. However, even this latest claim will be scientifically refuted in a forthcoming paper by Dr. Patricia A. Straat and me.

Beginning with Viking and increasingly over the intervening years, some scientists knowledgeable in the field have expressed their opinions on the LR martian results in private to me or in public statements. Thinking that other scientists might be swayed in their opinions by knowing how these experts have evaluated the Viking LR data, a list of those respondents was developed. Depending on what they said, the scientists were listed in the category of "Has Detected Life" or "May Have Detected Life." That list was then e-mailed to those named in it, and permission to include each one's name in a public article was requested. The updated list, with each name approved for such use, is shown in the accompanying Table 1.

In light of the continuing controversy, perhaps a review of the Viking LR data by an independent panel, against the background of what we have learned since Viking about Mars as a habitat and about extremophiles on Earth, could resolve this major scientific issue. At a minimum, such a

TABLE 1. SCIENTISTS STATING THE VIKING LABELED RELEASE EXPERIMENT DETECTED OR MAY HAVE DETECTED LIFE

<i>Name</i>	<i>Institution</i>	<i>E-mail</i>
<i>Life on Mars was detected by the Viking LR experiment</i>		
Giorgio Bianciardi	Università di Siena, Italy	GBianciardi@yahoo.it
Francisco Carrapico	Universidade de Lisboa, Portugal	F.Carrapico@fc.ul.pt
Mario Crocco	Ministry of Health, Buenos Aries, Argentine Republic	Postmaster@neurobiol.cyt.edu.ar
Barry DiGregorio	University of Buckingham, United Kingdom	Barry.Dig@verizon.net
Richard B. Hoover	Athens State University, Athens, AL (NASA ret.)	Entogonia@aol.com
Joop M. Houtkooper	Justus-Liebig-Universität Gießen, Germany	JoopHoutkooper@gmail.com
Gilbert Levin	Arizona State University, Tempe; LR Experimenter	Gilbert.Levin@asu.edu
Ron Levin	Lockheed-Martin, Goodyear, AZ	RonLevin@cox.net
Robert Lodder	University of Kentucky, Lexington	Lodder@uky.edu
Joseph Miller	American University of the Caribbean School of Medicine	JMiller2@aucmed.edu
John Newcomb	NASA, Viking Manager (ret.)	JNewcomb1@cox.net
Elena Pikuta	Athens State University, Athens, AL	EVikuta@gmail.com
Patricia A. Straat	NIH (ret.); LR Co-Experimenter	PStraat@comcast.net
Hans Van Dongen	Washington State University, Spokane	HVD@wsu.edu
Chandra Wickramasinghe	University of Buckingham, United Kingdom	NCWick@googlemail.com
<i>Life on Mars may have been detected by the Viking LR experiment</i>		
Timothy Barker	Wheaton College, Norton, MA	TBarker@wheatonma.edu
Steven Benner	University of Florida, Gainesville	SBenner@ffame.org
Paul Davies	Arizona State University, Tempe	Paul.Davies@asu.edu
Sergio Fonti	Università del Salento, Italy	Sergio.Fonti@unisalento.it
Robert Hazen	Carnegie Institution, Washington, DC	Hazen@gl.ciw.edu
Chris McKay	NASA Ames Research Center	Chris.McKay@nasa.gov
Richard Meserve	Carnegie Institution, Washington, DC	RMeserve@ciw.edu
Michael Mumma	Goddard Space Flight Center	Michael.J.Mumma@nasa.gov
Vincenzo Orofino	Università del Salento, Italy	Vincenzo.Orofino@unisalento.it
John Rummel	East Carolina University, Greenville, NC	RummelJ@ecu.edu
Dirk Schulze-Makuch	Washington State University, Pullman	DirkSM@wsu.edu
Andrew Steele	Carnegie Institution, Washington, DC	ASteele@ciw.edu
Carol Stoker	NASA Ames Research Center	Carol.R.Stoker@nasa.gov
Mike Storrie-Lombardi	Kinohi Institute, Pasadena, CA	Mike@kinohi.org
Henry Sun	Desert Research Institute, Reno, NV	Henry.Sun@dri.edu

review would help NASA better formulate its plans for future Mars missions.

In conclusion, I recommend the following actions in pursuing NASA's "Holy Grail" of life on Mars:

- (1) Implementation of Curiosity's liquid extraction protocol for organic compounds.
- (2) Taking of high-resolution close-ups of green spots on rocks by Curiosity's Mars Hand Lens Imager.
- (3) Review by an expert panel of the 1976 Viking LR data and other information pertinent to life on Mars.

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Submitted 27 October 2014

Accepted 3 November 2014