VIKING LIFE DETECTION REVISITED: THE GOOD, THE BAD, AND THE UGLY. B. C. Clark[1], [1]Space Science Institute, 4750 Walnut St., Boulder, CO 80301, USA. bclark@spacescience.org

Introduction: The Viking lander missions were the first and only attempts to robotically detect extant life by *in situ* measurements on a planetary body. Widely anticipated by scientists and the public, its results were, in the end, disappointingly negative [1]. What can be learned and applied to the future? [2].

The Good: The Viking Lander Biology Instrument (VLBI) squeezed 3 diverse and highly sensitive investigations inside an allocated volume of < 1 ft^3.

Science. The VLBI experiments comprehensively searched for metabolic activities of heterotrophy, chemoautotrophy, and phototrophy. Samples were taken from the surface and under rocks. Incubation conditions included dry, humid, and wet-gradient modes. Experiments were conducted with and without added nutrients, up to "chicken soup". Incubation and sterilization temperatures could be altered. GC columns analyzed gases, and highly sensitive ^{14}C monitors assayed for fixation and/or release of CO_2/CO. (review and critiques to be discussed.)

The GCMS goal was analysis of composition of soil organics down to ~ppb levels. It also provided semi-quantitative measurements of soil H_2O. Detailed MS analysis of atmospheric composition and isotopes proved the SNC basaltic achondrites are meteorites from Mars, preceding sample return by decades. Sans organics, the soil was found to be unexpectedly rich in salts (S, Cl, Br) and an oxidant that decomposed with humidification. Duricrusts enriched in $MgSO_4$ were evidence of activity by liquid water.

Operations. The Project directed "casual dress" (no ties) and went "badgeless" (no Institutional ID's). Software updates were permitted during the Extended Mission (post ~90 days), simplifying Surface Ops.

The Bad: *Engineering Constraints.* Limited volume was available for science because the Saturn V had been de-scoped. Only up to 4 incubation chambers were provided per investigation. At the time, VLBI was the most complex and expensive instrument ever commissioned by NASA.

Science. Small Team compared to today (50 for two landers vs 450 on MSL). Few early career scientists and no soil science experts. Testing of VLBI experiments emphasized non-Mars-like "Aiken soil." Geochemistry of Mars was unknown (lunar basalt, "limonite", high-silica analogs were all incorrect). Endolithic organisms could not be sampled. Viking-2 did not dig for ice. No exposures to H_2 nutrient. A published statement by Nobelist J. Lederberg prior to Viking pre-biased against life if organics not found. Mantra of "If Life is anywhere, Life is everywhere" is no longer accepted. Organics under pyrolysis can be decomposed by soil oxidants. Only two ovens operational in GCMS; 30 sec flash heating to 500 °C.

Project Constraints. The engineering P.M. could, and often did overrule the P.S. The Wolf-trap experiment was deleted, after huge VLBI cost overruns.

The Ugly: Viking was an enormous engineering success, but in the minds of the public, a scientific fizzle. Expectations and hopes for detecting life were too high, and too many scientists compounded disappointment by proclaiming Mars yielded no significant surprises (except, "lots of rocks"). Results were the same at both sites. Mars was becoming boring.

Furthermore, many of the scientists had strongly established reputations to defend. Humor was rare. For most, this would be their one and only space mission.

Unfortunately, two of the biologists who had initially worked together on the experiment that gave partial positives reached extreme opposite conclusions: "Viking detected life!", vs "it not only didn't detect life but Mars today is not a suitable abode". Consequently, the NASA Mars exploration program disappeared for the next 20 years. The flight-qualified 3rd lander never flew, in spite of proposals for launches in 1979 and 1981, and in spite of POTUS having asked NASA how soon another mission could be mounted.

Post-Apollo, NASA officials were forbidden from talking about or even simply studying human missions to the red planet. Mars was dead.

Today's Reality: That Mars is a fascinating planet with a long, diverse history, much of which has involved liquid H_2O, is now widely recognized. Sample return for M2020 does not currently preserve cold temperatures needed for investigation of LR results.

Missions which emphasize more and more the importance of "understanding" the complexities of smaller and smaller sedimentary settings (e.g., VRR) may intrigue scientists, but are less and less interesting to the overall public, our most important stakeholders.

As Carl Sagan once told me, years after the Viking public disappointments, for future missions to Mars "it still is all about Life." Now is the time to reconsider the search for extant life and signs of its predecessors. The search for biosignatures should continue, but investigations for inducing emergence from dormancy and activation of metabolism should also be explored.

References: [1] Klein, H.P. (1978), *Icarus*, 34, 666-674. [2] Clark, B.C. (2018), in *Handbook of Astrobiology*, V. M. Kolb, Ed., CRC Press, pp. 801-817.