Book Review of *MARS*, Kieffer, H.et al.
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Lowell's Legacy
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The splendid cover of this mammoth tome provides an overdue fresh look at the color of the so-called "Red" Planet. This might be interpreted to promise a new look at the other key debate about Mars¾life. Alas, you still can't judge a book by its cover!

In 38 chapters, 114 authors present facts and theories about Mars, including its history and cultural significance; composition, mineralogy, and internal structure; topography and surface features, geodesy, cartography, and stratigraphy; volcanism, cratering, and channels; atmospheric water and regolithic ice; climate changes; atmospheric composition and dynamics; dust and aeolian processes; physical and chemical weathering; the chemical activity of its surface material; the possibility of past or present life; magnetic field and solar wind; and the origin, geodesy, and cartography of its moons. There are 18 color plates, and accompanying sepia topographic and colored geological wall maps of the polar and equatorial regions.

Unfortunately, the editors have not arranged this sprawling survey in accordance with the relative significance of the many subjects it addresses. This is abundantly clear in the inadequate and unbalanced treatment of the possibility of life. For example, the chapter by R.O. Pepin and M.H. Carr entitled "Major Issues and Outstanding Questions" devotes only a half dozen glancing sentences to that vital question about Mars. Therefore, this review will deal primarily with the book's (mis)treatment of that issue.

Likewise, "The Search for Extant Life on Mars" by H.P. Klein, N.H. Horowitz, and K. Biemann¾the sole chapter devoted to the *raison d'être* of the billion-dollar Viking project¾fills a mere 0.7 percent of the book. The editors did not seek input from this reviewer, the Viking experimenter whose Labeled Release (LR) experiment provided strong evidence of living microorganisms on Mars. Instead, the LR data are co-opted by the chapter's authors as evidence *against* life and *for* putative oxidants in the soil. While this chapter does cite the works of 10 scientists representative of those who "feel there may well be active biology on Mars," their cases are not presented.

Omitted is the fact that the results of nine LR experiments on Mars exceeded the criteria for the detection of life. These criteria had been accepted, prior to launch, by the Viking Biology Team (including two of this chapter's three authors), and by all the review committees. The authors also ignore intensive research and remote sensing from earth and Mars orbits that failed to support the oxidants thesis.

The authors' main argument against the LR experiment is that the Gas Chromatograph Mass Spectrometer (GCMS) Experiment of coauthor Biemann found no organic matter on Mars. The authors fallaciously dismiss important evidence that the LR found living microorganisms in a sample of Antarctic desert soil in which the GCMS was unable to detect any trace of organic matter. Their proposal is that the soil had become contaminated in the years before it was tested by the LR.

Actually, no such interval occurred. Because the GCMS results were not published until years later, the *comparison* was delayed. The late GCMS report also revealed that a standard chemical test of the same sample did find organic matter. As Biemann states, the GCMS requires the organic content of one million living cells to produce a response. The LR detects as few as 10 cells.

The chapter omits any reference to work by Horowitz indicating that organic matter in amounts that "could be" considerable over geological time" are formed on Mars. Other important evidence for organic compounds on Mars is neglected: the SNC meteorites (generally agreed to be of Martian origin) contain organic compounds, and the infall of interplanetary dust delivers thousands of tons of organic-laden particles to the surface of Mars annually.

According to Klein and coauthors, Mars was "de-Lowellized" (the verb is a swipe at the late U.S. astronomer Percival Lowell, who was convinced that the existence of water permitted Mars to be inhabited by intelligent life) by Mariners 4, 6, 7, and 9, which revealed that "liquid water could not exist on the surface," making the search for life an impossible quest for Viking.

This would perhaps come as a surprise to B.M. Jakosky and R.M. Haberle, who report in another chapter on "The Seasonal Behavior of Water on Mars." They cite the exchange of atmospheric water vapor with the Martian surface and discuss the availability of water as a pure liquid or as a brine or ice. Fog and frost were seen at both Viking landing sites. One wonders whether Martian organisms, deprived of water over time, might have evolved to glean water from atmospheric vapor, as do some lichen on earth, or to exist within the few layers of liquid or absorbed water cited by Jakosky and Haberle. After all, life on earth could not exist if plants had not evolved the ability to scavenge carbon dioxide from the scant 0.03 percent present in the atmosphere.

In “The Possibility of Life on Mars During a Water-Rich Past,” C.P. McKay and his coauthors speculate that the loss of water on the planet¾which had a temperate climate and flowing water for a period longer than that which gave rise to life on earth¾might have killed any existing life. They therefore advocate a search for fossil evidence.

A. Banin and coauthors, in “Surface Chemistry and Mineralogy,” also use the LR data, not as evidence of life or oxidants on Mars, but rather of clays. In claiming to have duplicated the LR Mars data, they ignore published criticism that their unsterilized clays would readily produce an LR response.

As to the debate over the planet’s color, Viking’s first image of the Mars landscape showed an Arizona-desert-like landscape under a mild blue sky. This was quickly adjusted to a monotonously red landscape and a salmon-pink sky, which became the official version. Hence my surprise at the sudden reappearance of the Arizona-type landscape gracing this book’s cover, even if the accompanying Hoagie Carmichael buttermilk sky still does not comply the cerulean hue that Rayleigh scattering would seem to require. This provocative color issue is confined to one brief paragraph in “The Martian Surface Layer,” by P.R. Christensen and H.J. Moore, who remain in the red camp. No other author approaches the subject.

Any atmosphere of colorless gases (as is Mars’s) lets the sun’s red light through but scatters the blue, which colors the sky. A red sky therefore requires that the atmosphere preferentially scatter red light. Proof that direct, not scattered, sunlight provides the predominant illumination on Mars is provided by the dark shadows of rocks. In scattered light, those areas would be lit. Were red light scattered by dust or other means, the landscape (and the Viking color-calibration chart) would have appeared biased toward the blue.

The main questions raised by this book concerns not Mars, but why *Mars’s* contributors and editors so carefully tiptoed through the data. Is it fear of tar from Lowell’s brush, peer (review) pressure, politics, or some combination thereof? Alas, the answer is not to be found in this book.

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