

THE MEANING OF MARINER IV

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had shrunk the
mission so that
some very interesting
and sophisticated
experiments
originally planned
had to be
deferred.

Mariner IV was more than an extraordinary technological achievement, it was an event of major scientific significance. The pictures showing a heavily cratered surface, devoid of evidences of aqueous erosion or mountain building activity, and the observed absence of a magnetic field are new, fresh clues to the nature and history of Mars. Not only has the public image of the "mysterious planet" been directed away from that of intelligent life residing on an earth-like planet by this new information, but the opinions of specialists have also been sharply focused.

Only a week before the Mariner IV encounter with Mars in July, a broadly representative group of scientists was meeting at Wood's Hole Massachusetts under the aegis of the National Academy of Sciences. Their task was to consider the most important objectives for the lunar and planetary exploration program of the United States over the next decade. Mars received particular attention. The search for evidences of an ancient ocean on Mars was considered to be among the most important tasks. The geologists in the group discussed the possibility that layers of sedimentary strata which had formed on the bottom of such ancient oceans might even be disclosed in close-up photography by tell-tale erosional patterns. Three weeks later the Mariner IV pictures, covering less than one percent of the surface of the planet at a resolution no better than a mile or two, nevertheless made it clear that any large scale physiographic relics of ancient Martian oceans, had they ever existed, almost certainly have been erased by the subsequent meteorite and asteroidal bombardment so vividly recorded there now.

Similarly, the scientists at Wood's Hole had pointed out that large scale internal activity such as that which produces mountains and earthquakes on the earth, even the continents

In many respects, the results of Mariner IV have overreached reasonable expectations of what could be learned from a foray with rather low resolution. It is hard also to recall that the exigencies of space technology during the past few years.

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and oceanic basins themselves, should also leave tell-tale topographic signatures on the Martian surface if that planet were also internally dynamic. ~~The degree of preservation~~ *But Mariner IV shows a* of the present cratered surface, free from the destructive effects of major mountain building activity, ~~is apparent in the Mariner IV photography.~~ *apparently* This limited visual reconnaissance suggests, but does not prove, that Mars has been quiescent *at least by comparison with earth* since the present surface formed, if not always. The absence of a detectable magnetic field is an additional strong bit of evidence in favor of a passive planet, particularly because Mars spins on its own axis as rapidly as does the earth. The earth's magnetic field is generally believed to result in some way from the interaction of a ^{mobile,} liquid core with its high spin rate.

Thus Mariner IV has, in a ~~veritable instant,~~ *transformed and sharpened the* changed even some of the questions *one flesh* scientists would place ~~at highest priority.~~ *is the set of* It has pushed Mars closer to the Moon in cosmic *is the set of* genealogy than many scientists had thought previously; it has ~~narrowed and sharpened the~~ *brought new substance to* discussion of the age and nature of Mar's surface. It ~~has been a most resounding scientific~~ *elusive* success because it ~~acquired and returned~~ *strange* new facts about Mars, facts forever beyond our reach from the surface of the earth, facts even partly beyond our imagination, ~~There simply was~~ *hard facts on which to* too little information about the surface of Mars upon which even to speculate effectively. *build the disciplined theorization which is the flesh and blood of scientific progress.*

Mariner IV was preeminently a scientific exploration; Its success is the ~~unpredictable~~ result of a bold look at the surface of another planet. There ~~simply~~ *in advance* was no way ~~to be~~ sure that ~~at least some~~ significant physiographic features would be present in the pictures. *A photographic mission to* The Earth itself generally would not be too interesting if photographed in a similar manner, *from Mars would not have told much more than could be deduced by* except for extensive water vapor cloud patterns and oceans. Yet the United States had the *telescope from the surface of the other planet.* imagination to take a chance on exploration and had also the skill to make it succeed technically.

The meaning of Mariner IV today is that we have reached an historic milestone in Man's exploration of the universe around him: we now have the confident capability to explore directly the nearby planets. The meaning of Mariner IV for the future is that we can have confidence that that exploration will return even greater scientific dividends. Mariner IV is

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and
a spectacular reminder that a wondrous new episode in the Age of Exploration is beginning. We may expand our consciousness to include the planets if we really wish to.

But where next? Isn't Mars so obviously like the Moon that we should concentrate on some other planet? Isn't it apparent that Mars is lifeless? Our answer to such rhetorical questions would be to emphasize the lessons we have just learned. Explore! If a tiny bit of exploration has been so rewarding, imagine what can be hoped for with the vastly larger capability now becoming available.

The quest for extraterrestrial life is the greatest challenge we can imagine. The surface of Mars is still the best place by far to start that search. Certainly, it would have been particularly exciting if dried up ocean bottoms and ancient river drainage patterns had characterized the terrain. Then we would have felt almost certain that life once existed there. Furthermore, laboratory experiments have shown that even some terrestrial microorganisms can live and multiply under present Martian surface conditions. Hence, many scientists feel that if simple life ever had gotten started on Mars, there should still be some there.

The Mariner IV pictures, of course, do not rule out the possibility that Mars did indeed once have oceans and a thick atmosphere with liquid water present at the surface. Although perhaps this seems less likely now than before Mariner IV, it is still possible that such circumstances did prevail at some time in Mars's history, then gradually disappeared before the present surface was formed.

On the other hand, that present surface ~~by itself~~ ^{still} may represent a suitable place for the formation of simple life forms. Mars, unlike the Moon, has a thin atmosphere which must have come from the interior over the course of time. The Martian atmosphere is known to contain substantial amounts of carbon dioxide and about the amount of water to be expected in vapor form over ice, presumably the main constituent of the polar caps of the planet. Now it is most likely that whatever process liberated water and carbon dioxide from the primordial matter of Mars also liberated substantial quantities of organic compounds like methane,

ammonia, and hydrocarbons. Such compounds must have been concentrated at various times and various places in the Martian soil. The surface ^{at the very} temperatures get above freezing just due to solar heating in equatorial regions on Mars. ^{We must then consider} ~~and there may well be~~ isolated internal sources of heat that produce local "oases" - perhaps, the same sources of heat connected with the degassing of the planet itself. Thus, there may well have existed at some places on Mars the chemical and physical conditions necessary for the initiation of simple life forms.

Such a "model" is unaffected by the Mariner IV findings; It is, in fact, the picture many biologists and other scientists ^{seem to} had developed as a guide to the possible biological exploration of Mars long before Mariner IV. It is primarily on the basis of such a picture, along with secondary hopes of ancient oceans, that the National Academy of Sciences recommended last year to the National Aeronautics and Space Administration a large scale and aggressive program of exploration of Mars leading to eventual direct tests for, and analysis of, life forms that may exist there. ^{More precisely, the aim is to survey Mars as a planet more primitive than the earth from which}

None of the results from Mariner IV significantly change the basis for the NAS recommendations. Mars is still the best, and a most promising, place to search for extra-terrestrial life. Mars is certainly a most exciting and informative place to explore from the non-biological point of view as well.

The meaning of Mariner IV to us is that we should ~~vigorously and imaginatively utilize~~ ^{has no more creative challenge than} our growing space capability to follow up Mariner's unexpectedly informative "First Close-Up Look" with a ^{vigorous} ~~bold~~ long range program of Martian exploration, ^{over a breadth of scientific disciplines} both biological and non-biological. There will be only a brief instant in human history when Man first becomes familiar with the surface of another planet. Only one or two nations will have the opportunity to carry out this endeavor. If we but wish it to be, that instant can be the coming decade and this nation will remain at the forefront of a great human adventure.

we can learn more about the conditions of the early origins of life. Biochemical fossils of false starts in the evolution of life would almost make up for our disappointment if we can find no evidence of a more successful "experiment" on Nature's part. But until we have more real knowledge about the details of Mars surface, this remains the exciting question

Large amounts of primordial materials that would have been baked out into the atmosphere of a warmer planet must still be locked up in Mars crust - most important of these materials would be water in the form of ice or permafrost.

and we have no right to prejudge it.