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Chapter 8

REACHING FOR THE PLANET MARS: HUMANKIND'S EVOLVING PERSPECTIVES*

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"Mars and Venus definitely possess atmospheres, and this was enough to convince the optimists that they also possess advanced forms of life. The idea that their atmospheres might be utterly unbreathable was an affront to common sense" [7, p.148].

Arthur Clarke (1968) notes that ". . . the universe seems to delight in affronting common sense." This paper explores the evolving view of Mars. Around the globe, early man saw Mars as a pinpoint of light. Contrast their perspectives—Romans, Inca priests and Chinese—2,000 years ago, with the view of particles of yellow atmospheric dust and reddish sand grains on the Martian surface from the Mutch Memorial Station (Viking Lander 1), between touchdown on 20 July 1976 and loss of contact on 13 November 1982 [2].

In the previous paper [13], the evolution of concepts for a lunar base was discussed. This paper reviews humankind's view of the planet Mars, of the Martian environment and the possibilities of life on Mars. The quest for an understanding of Mars is viewed as a drive for man to better understand himself and his own home, planet Earth.

The following sections develop the theme of the evolving perspective, looking at the historical background, considering the solid surface of Mars, the waters of Mars, the veil of Mars—the atmosphere, Mars as a garden, and life on Mars. The paper concludes with a discussion of the meaning of humankind's evolving perspective from the standpoint of comparative planetology and humankind's future on Earth.

HISTORICAL BACKGROUND

In the Fifth century B.C. the Greeks observed in space five bodies they referred to as wanderers—our word "planets." In addition to Mars, they identified

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Mercury, Venus, Jupiter and Saturn. Plato subsequently grew up in an age when the idea of a flat Earth was rejected. Plato believed that celestial bodies move in circular orbits caused by divine beings. In the *Republic* he keeps the planets (including Mars) in motion with the services of Necessity and her three daughters, the Fates. The fact that the planets sometimes appeared to move backward was taken into account by allowing the Fates (God) to sometimes lose control and cause a reversal of motion [8]. Time running backward had many implications.

To the Babylonians, who noticed that the Sun, Moon and planets move in a circular band in the sky, everyone's life was determined by the qualities of the planets in or near his sign of the zodiac. The planets were gods and goddesses with varying amounts of power. Man, hence, was at the mercy of gods and goddesses who presided over his birth. The Alexandrians adopted the Babylonian ideas, while working out an otherwise rational view of space. Man became prisoner of the zodiac.

In the early 1600s, Brahe and Copernicus argued the relative merits of competing theories, one of which had the Sun, Moon and planets revolving about the Earth, and the other which had the planets revolving about the Sun. Kepler and Brahe studied the orbit of Mars. Brahe's observations of many years were bequeathed to Kepler, who noted subsequently that the time it takes a planet to go around the Sun is mathematically related to its distance from the Sun.

At the age of 45 in 1609-1610, Galileo began observing with a 33-power telescope. For his deductions, he was, at the age of 69 or 70, found guilty of heresy for declaring that the planets (the Earth included) move about the Sun. Presented below is a Martian chronology beginning in 1610:

A CHRONOLOGY

1610	Galileo - First telescope observations of Mars.
1659	Huygens - Drawing of Martian topography.
1666	Cassini - Noted Mars rotation period.
1869	Father Secchi - Noted Canali.
1877	Asaph Hall - Sighted Phobos and Deimos.
1877	Schiaparelli - Named Martian topographic features; noted markings he called Canali.
1877	Green - Noted clouds.
1882	Flammarion - Noted energetic activity on Mars.
1892	Pickering - Saw oases.
1894	Lowell - Founded Lowell Observatory.
1894	Barnard - Declared canals are a fallacy.
1916	Lowell died.

Immanuel Kant, born in 1724, wrote in his *Universal Natural History and Theory of the Heavens* that the rings of Saturn were to come together to produce Moons, and that the inhabitants of Mars (a hot place) are "in every way dense." In *Gulliver's Travelers* it was "prophesied" that Mars had two moons, and, amazingly, their existence was confirmed in 1877 by Asaph Hall [3]. Also, in 1877 the "canals of Mars" were seen by Giovanni Schiaparelli [18]. Giovanni was cautious but others extrapolated to visualize irrigated deserts and even underground cities. As late as the 1930s, some astronomers believed that Martian canals existed and had been dug by intelligent Martians to water patches of vegetation. In the *Martian Chronicles*, Ray Bradbury imagines Mars as akin to a hot, dusty midwestern prairie. A spacecraft lands on Mars, and the spaceman claims to have come from Earth. He is shot by a Martian, who claims that the Earth could not support life, because there is too much oxygen in the Earth's atmosphere. Besides, the Martian is jealous, because the claimed Earth man sang a love song to his wife. One character from a Robert A. Heinlein story is a Martian who can establish rapport with someone only by sharing water—whether in a glass, or while swimming or bathing.

Over 100 years ago, astronomers proposed communications with Martians by means of giant bonfires in the Sahara Desert, where the layout of flames would illustrate the Pythagorean Theorem. In July 1976, the *Viking 1* spacecraft lander saw Mars up close as a desert. The canals are optical illusions. The "vegetation" is streaks of dust whipped by winds. The twin satellites (Phobos and Deimos—Fear and Terror) are cratered rocks. From V-2 rockets to the books of Bonestell and Ley to the conceptual designs of von Braun and later visionaries, the dreams of flight to Mars have been pursued. Various scenarios have been suggested for a flight to Mars [6]. One involved a nuclear rocket 260 feet long, launched from Earth to rendezvous with additional fuel tanks in Earth orbit. Seven men were then off on a 180-day flight to a Mars parking orbit. Two men spend 10 to 40 days on the surface after a 350-mile descent with the aid of rockets and a parachute. The trip back to Earth, after rendezvous in Martian orbit, requires 200 days. An alternative trip, with only a Martian flyby and using Saturn V technology, anticipated a 641-day trip beginning August 14, 1973, and ending back home May 17, 1975 [6]. Longer term goals on Mars include tapping water in permafrost, erecting glass-enclosed habitats, and planting and harvesting crops on Mars.

THE SOLID SURFACE OF MARS

Mariner 9 watched Mars and waited for the obscuring dust storm to abate in November 1971. The men controlling this spacecraft were members of a society not far removed from the fiction of Heinlein and the science of Lowell. Previously, *Mariner 4* and *6* had sent back scenes of Martian craters. Opik in 1951 had prophesied that there would be found on Mars hundreds of thousands of craters exceeding Meteor Crater (Arizona) in size [6]. Dean McLaughlin subsequently had suggested the presence of volcanic ash which implied the existence of volcanic terrain of some kind. Willy Ley [3, p. 110] wrote, ". . . There are no real mountains anywhere on Mars." The evidence was the lack of perceived prominences on the limb as viewed from Earth. Ley went on to say that the main features of Mars were stark monotony. Ohring [17, p. 49] reviewed the evidence after the early Mariners and noted, "It took just one photograph to present the scientifically startling fact that Mars is covered with craters." In contrast to these beliefs, Carr and coworkers [4, p. 3985], noted that "One of the most exciting results of the *Mariner 9* mission was the discovery of huge volcanoes on Mars." The Mars we now know has a diverse volcanic history. There is volcanic material associated with many landforms. The surface has impact craters and deserts but is dominated by neither except on a local scale. It is not monotonous in many locales. Mars has traditionally been viewed as the red planet. It appears to Viking as a dark brown to yellowish brown surface with some dark grey rocks [11, p. 4401].

Another astonishing scene on Mars (in addition to the *Olympus Mons* volcano, which is the size of Colorado) is the giant chasm now referred to as *Valles Marineris*, which is the length of the United States [5, p. 173]. In addition, there are extensive features on Mars, which have an appearance similar to what we know as river valleys.

Sand dunes in vast fields on Mars suggest erosional processes which, some [10, p.75] believe, are less active now than in the recent geologic past. The suggestion is that, when the dry riverbeds and other factors are taken into account, Mars was once more Earth-like than it is now. Another point of view from some analysts is that ". . . Mars is becoming more active. . . ." Perhaps only in the geologically recent past has Mars heated up to a point promoting active volcanism [10, p. 85].

THE WATERS OF MARS

To early students of Mars it was an affront to the intellect to consider Mars other than a habitable world. The darker areas were seas and the comparison was made that while the surface of the Earth had large areas covered by water, the surface of Mars had much lesser water covered area.

What has been noted by Viking on Mars instead is [24, p. 3968] widespread evidence of catastrophic flooding. The source, sinks and nature of the fluid involved are unknown. There is evidence of ice on the polar caps, which is there in quantities many orders of magnitude greater than in the Martian atmosphere today.

In 1894, Mars was presented by Lowell as a dying, drying world late in its evolution [10]. It has a smaller size and faster cooling rate than Earth. The once humid surface has little water, and for the men on Mars irrigation is an urgent necessity.

Chapman [5, p. 183] noted that ". . . inherent in this new Viking perspective of Mars is an element of instability: if . . . arctic processes can form the fascinating Mars scapes (jumbled terrain, and polar ice) pictured by Viking, and if Martian surface layers depend so precariously on the near surface freezing point of water, think what just a bit of climate warming—in the past or future—might mean for Mars!" He is alluding to the possibility that a temperature rise could free water conceivably trapped in the polar icecaps and in the ground as permafrost. There may be freeze-thaw cycles near the Martian surface in the permafrost [15, p. 4522].

THE VEIL OF MARS—THE ATMOSPHERE

In 1909 [10] E. W. Maunder of Greenwich Observatory estimated the Martian atmosphere at 14 percent of the terrestrial atmosphere. The trends for estimates of the Martian atmospheric pressures have ranged from a value of 1000 millibars in 1900 (by Lowell) downward as in Table 1.

Table 1

ESTIMATES OF MARTIAN ATMOSPHERIC PRESSURE

YEAR	PRESSURE (millibars)	SOURCE
1909	140	Maunder
1950s	85	Several sources
1962	83-89	Slipher
before Mariner 4	15-25	Occultation
after Mariner 4	5-8	Occultation
Mariner 9	2.8-10.3	Occultation
	3-11	North polar cap

Soffen [24, p. 3970] estimated that Mars has not outgassed as much as Earth. The present Martian atmosphere is thought to be only a small fraction of the past atmosphere. Mars may have had an ancient (on a geologic time scale) atmosphere of 50 to 100 mbar. At the *Viking 1* and *Viking 2* Lander sites, pressures were 7.62 and 7.81 mbar respectively [23, p. 4346]. The atmospheric pressure varies considerably with time.

By the 1930s, the evidence suggested that the Martian atmosphere was very thin and contained little oxygen. Between 1934 and 1941, from observations using the Mt. Wilson 100-inch reflector, it was deduced that the oxygen on Mars was less than 1 percent of that above the Earth's surface, and the amount of water vapor is low [10, p. 10].

Kuiper's results published in 1947 revealed the presence of carbon dioxide in the Martian atmosphere, the virtual lack of oxygen and a scarcity of water vapor [10, p. 11]. Clarke [7, p. 148] notes that this atmospheric condition ". . . at once ruled out all known forms of animal life—as well as a whole category of science fiction." There could be no Martian princesses and not even a Martian mouse.

There is nevertheless an atmosphere stirred by local and global dust storms at least once each Martian year [21, p. 4430]. Winter is one time of high winds. Mars may have had an atmosphere substantially more dense than at present, which either was 90 percent removed by a catastrophic event, or Mars never outgassed as much as Earth [19, p. 4637].

MARS AS THE GARDEN

"The combined *Mariner 9* and Viking observations contain no convincing evidence to support the once traditional concept of a seasonal wave of darkening" [26, p. 4167].

In the 1950s, it was concluded by Kuiper [10] that, "The hypothesis of plant life . . . appears still the most satisfactory explanation of the various complex dark markings and their complex seasonal and secular changes." Salisbury [22, p. 138] noted "In the Martian spring a wave of darkening spreads toward the equator from the poles. During summer the markings remain dark, then fade again in winter." This wave referred to by Salisbury was thought by some to be evidence of vegetation and by others to result from atmospheric moisture.

LIFE ON MARS

Klein [14] states ". . . We must conclude there are no organisms present within the limits of detectability for these experiments and that all the observed reactions for these were the result of nonbiological phenomena." Klein continues his report by noting that to conclude otherwise would be to question the fundamental assumptions made and the conditions for the experiments. It is not necessary to postulate biological processes in order to explain any objects or processes observed on Mars during the Viking data and image collection process.

In the early 1800s, Mars was to humankind a world of oceans and lakes, dry reddish land, clouds, polar snows and a 24-hour day. Mars was very Earth like. In these days before Darwin, Hershel and his contemporaries assumed that Mars and other planetary bodies were inhabitable [10, p. 2].

Mars may have supported civilizations long before the first life on Earth emerged from the sea [7, p. 149]. Mars is the only planet we can explore without extreme difficulty, and we will eventually be in a position to dig and search for evidence of past life along the ancient Martian riverbeds. Another view is that we may be observing Mars early in its biological evolution [20, p. 4478]. By comparison, for over 80 percent of the history of life on Earth, only microbes were to be found.

WHAT DOES ALL THIS MEAN?

Man works out his urge to better understand himself and his environment by taking fragments of data and a surging imagination and extrapolating to working hypotheses. The hypotheses, whether crude or elegant, true or false, seek to explain relationships of physical objects and ultimately the state of humankind and causes of changes in the terrestrial environment. Always the challenge has been to make the best use of incomplete and limited data, to strive to obtain more data, and to test the working hypotheses and reform them, so they more closely approximate an unseen reality.

Even today, after the *Mariner 9* and Viking missions, we have a very incomplete knowledge of Mars. Our theories and working hypotheses will appear as primitive to future voyagers as the scientific biases of the early proponents of Martian seas and canals appear to us. The road to an understanding of the dynamics of the solid body and atmosphere of Mars is an unending one. And we have just begun the journey.

Mars holds many more surprises for us and our children. Humankind will continue to grapple with a troublesome adolescence on Earth and an incomplete understanding of its ecology. The maturation process for man is a struggle between reaching out to new worlds and an inward course of torments, doubt and potential self-destruction.

Man's perspective of Mars has evolved as man's perspective of himself, his gods and his position in the universe, have matured. To the Greeks, Mars was a point of light – a wanderer in the night sky to be rationalized in terms of Man's own subservient place in the universe. Today the dynamics of the Martian surface and atmosphere hint at terrestrial processes of potentially profound significance.

A NEW PERSPECTIVE – COMPARATIVE PLANETOLOGY

Mars is the keystone of a burgeoning science of comparative planetology. Comparative planetology seeks to improve man's understanding of the processes that form and modify the planets and their atmospheres. The thrust of this science is to view our own planet Earth in its solar system context [5, p. 174]. The planet Mars has become the domain of the geologist and the meteorologist and has raised many hard-to-answer questions about processes on Mars that reflect on the validity of ideas long held about the planet Earth.

The motivation to better understand Mars is in effect a motivation to obtain for man a better understanding of himself and his own ecology. By studying other environments mankind can learn to put a proper value on his home planet. The outcome of *Mariner 9* and the Viking missions to Mars promises a better understanding of how to use science and technology in sustaining life on Earth. Space is a great laboratory for man to learn the use of control, communications and power.

Man now dreams of re-forming Mars and other extraterrestrial bodies to nurture human life. This engineering effort will require the mastering of tremendous amounts of energy that we now do not possess. But the genius of man has been the capability to dream and adapt, and the possibility remains. To meet his needs, man in the past has been able to change both his own approach and his environment. One such dream of planetary engineering on Mars is contained in a recent book, *The Greening of Mars* [1].

WHAT HAS EVOLVED?

What has evolved is the understanding of the meanings and implications of increased knowledge of planets. Man has always realized in some vague way that the planets and their motions have implications for humankind. He has, through the ages, sought to gather data on the planets and input that data into a relational framework relevant to him and his planet.

The early astronomers concerned with the conjunctions of the planets, Percival Lowell and his followers, eager to learn of Martian canals, and the comparative planetologist of today, all have a message of their age. But the perspective continues to evolve.

Comparative planetology may have as its outcome the basis for saving humankind to reach ultimate potential. The discipline may help it to understand why Earth is a habitable environment, and which natural and man-induced phenomena are consistent with maintaining a habitable terrestrial environment and which are not. Such a goal probably cannot be attained by the study of only one planet by beings of that planet, because of the power of dogma and the likely inability to muster enough data to overturn the dogma.

Only two decades ago terrestrial continental drift was heresy [5, p. 187]. Why did it take several decades of stumbling down the wrong path for geologists to come to accept the concept? The answer lies in the sociological nature of science, wherein a model that seems to work (satisfies many diverse observations) cannot be easily discarded. A massive amount of evidence to the contrary is required to overturn dogma in a "mature" science. When dogma is divorced from reality, the community of scientists will tend to drive research in directions not consistent with what really are the critical issues and fundamental questions.

There is an urgency to understand the nature of the stability of the terrestrial environment now because of the power possessed by man. If man can understand how his actions influence his own planet's habitability, he may also obtain insights into how he could engineer new homes on Mars and elsewhere.

It has been noted that climate change caused by some mechanism is considered a likely hypothesis to explain how Martian river valleys could be formed in the past. Was this a gradual, uniform change or a catastrophic one? What are the implications for stabilities in the terrestrial climate in the past and in the future? Can man's actions cause a dramatic change in the terrestrial environment?

The essence of the purpose of the study of Mars is to fuel the engine that drives man toward the ultimate destiny—to understand himself and his position in the universe, and to understand the nature and future of humankind's present home. Humankind is now engaged in engineering on Earth on a planetary scale without the complete picture of the ramifications of the endeavor. From Earth, man can gain what amounts to one data point. Comparative planetology and associated studies can provide the infusion of new data and evidence that can rock old dogma and help define what really are the critical issues as man studies himself and his future on planet Earth. These considerations are not frivolous or peripheral when the potential impacts of humankind's activities on himself and his home are considered.

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