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The 6 May 2024 *Linn's Stamp News* had a cautionary article on counterfeit high-denomination Priority Mail James Webb Space Telescope (JWST) images stamps. The stamps were purchased through online sellers and are very convincing counterfeits of the genuine issues.

Planetary Environments Part 5: Mars (Part 1) by Garry Toth and Don Hillger ([Un-manned Satellite Philately](#))

This is the fifth article in the *Astrofax* series on planetary environments. Previous articles in the series appeared in the previous four issues:

1. *Planetary Environments, Part 1: Introduction* (Volume 31, Issue 2, Summer 2023)
2. *Planetary Environments, Part 2: The Moon* (Volume 31, Issue 3, Fall 2023)
3. *Planetary Environments, Part 3: Mercury* (Volume 31, Issue 4, Winter 2023)
4. *Planetary Environments, Part 4: Venus* (Volume 32, Issue 1, Spring 2024)

In a clear night sky, the reddish planet Mars attracts one's eye, and through a telescope the Red Planet beckons even more. The cover of the March 2021 issue of *National Geographic* states that "We can't get enough of the Red Planet." The story (Ref. 1) goes on to say that "The dusty Red Planet has fascinated us for centuries" before asking "Why are Earthlings so dang obsessed with Mars?" It seems that Martian mythology hooks us, and the obsession arises when we realize that the Red Planet is just enough like Earth, and close enough, that we can reasonably imagine going there one day. We are after all explorers at heart.

Mars and Earth are closest when Mars is in opposition (aligned with Earth on the same side of the Sun). The Martian elliptical orbit puts the planet at 1.38 au from the Sun at perihelion, and 1.67 au at aphelion. At the most recent *close* opposition, on 28 August 2003, Mars and Earth were about 55.8 million km apart. At the most recent *distant* opposition, on 3 March 2012, the two were separated by about 62.6 million km.



Figure 1. Guinea, Mi5752, 2008

Ancient peoples such as the Sumerians, Indians, Chinese, Egyptians, Mayans, and Greco-Romans, made visual observations of the five "wanderers" Mercury, Venus, Mars, Jupiter, and Saturn. They were mystified by their occasional retrograde motion. In the third millennium BC, the Sumerians associated the reddish color of Mars with "the malevolent deity Nergal, god of pestilence and war" (Ref. 1). Similarly, the Greeks named the planet *Ares*, the Olympian God of war and battle lust (Fig. 1). The name *Mars* comes from the

Roman equivalent of *Ares*. The adjective "martial" (warlike) has the same root, and a historic

martial context has become part of the mythology of the Red Planet. H. G. Wells' novel *The War of the Worlds* (Fig 2), published in 1898, features an invasion by an implacable Martian force. Orson Welles and his Mercury theatre parlayed the story into a Halloween 1938 radio broadcast (Fig 3), stoking fear among many that Martians really *had* landed in New Jersey! H. G. Wells' novel is only one of a surprisingly large number of [books that refer to Mars](#). There are also quite a few [films set on the Red Planet](#). Nor is Mars excluded from music. Gustav Holst's orchestral suite *The Planets* (Fig 4), first performed in 1918, begins with a movement titled *Mars, the Bringer of War*, with driving rhythms and dissonances that evoke violence and terror.



Figure 2. Great Britain, Sc 1618, 1995



Figure 3. Liberia, Sc 2843a, 2013

In the early Renaissance, astronomical work gradually extended the knowledge of the ancient peoples. Through Copernicus, Brahe, Kepler, and Galileo, the inevitable and revolutionary conclusion was that the planets, including Mars, move in elliptical orbits around the Sun. The

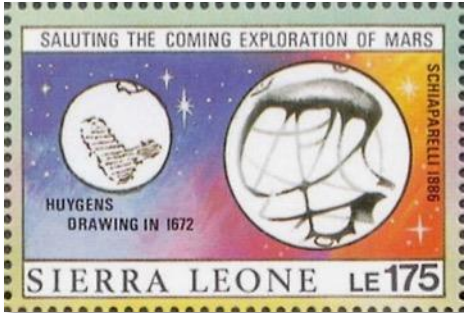


Figure 5. Sierra Leone, Sc 1167c, 1990

use of telescopes, combined with improved forecasts of the planets' movements, resulted in a great leap forward in planetary observations. In 1659, the Dutch astronomer Christiaan Huygens observed a dark area on Mars that may be what is now known as Syrtis Major. His drawing of it (incorrectly labeled "1672") is at the left side of the stamp in Fig 5.



Figure 4. Great Britain, Sc 1104, 1985

In the 1660s, Jean-Dominique Cassini observed the polar caps of Mars as bright spots (Fig 6, with text "1666 – Cassini observes the polar caps on Mars"). Then in 1719, his nephew, the French-Italian astronomer Giacomo Maraldi, found that his uncle's white spots grew and shrank and were not exactly centered on the Martian poles, and that the dark areas, such as recorded by Huygens, seemed to change shape. Could Mars have seasons? In the 1780s, English astronomer William Herschel observed similar phenomena and speculated that the dark areas might be oceans, the lighter areas land, and the bright polar spots sheets of ice and snow. He estimated that the tilt (from vertical) of the Martian axis of rotation was around 25° (Earth's is 23.5°). That supported the idea that Mars has seasons. He also noticed that stars passing very close to Mars were not dimmed, and therefore

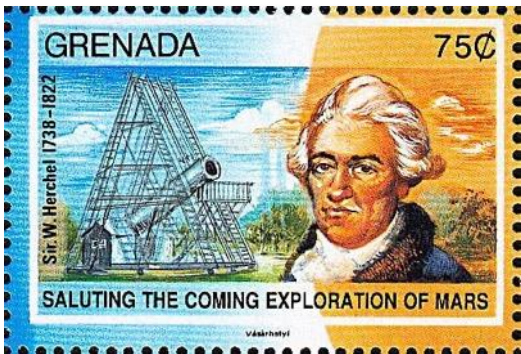


Figure 7. Grenada Sc1999d, 1991

inferred that the Red Planet must have a very thin atmosphere. His ideas were not all strictly scientific, though. He said that intelligent beings who "probably enjoy a situation similar to our own" inhabit the Red Planet. The stamp in Fig 7 salutes "the coming exploration of Mars", and, implicitly, Herschel's past contributions.

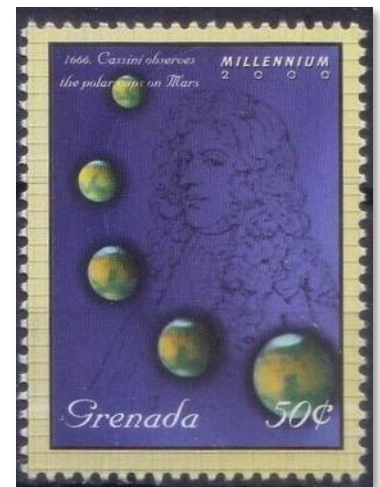


Figure 6. Grenada, Sc 2932o, 2000

In around 1809, the French astronomer Honoré Flaugergues saw variations in Martian yellowish features that he speculated must be in the atmosphere rather than on the surface. Could they have been dust storms? Critics of his work say that his telescope was



Figure 8. Italy, Sc 3518, 2018

too small to have allowed such an observation. However, in around 1858 the Jesuit astronomer Angelo Secchi (Fig 8) made similar observations with an improved telescope and found that surface features were sometimes obscured by a sort of “cloud” that could be interpreted as a dust storm. In the 1860s he observed dark channel-like surface features that he called *canali* (channels). The Italian astronomer Giovanni Schiaparelli observed similar features and used Secchi’s word for them. He is depicted in Fig 9 along with one of his drawings of the *canali* (that drawing is also found in Fig 5). Thus began a sort of international free-for-all. *Canali* was mis-translated into English as “canals”, whose connotations grabbed the public mind as well as that of some scientists. The American astronomer [Percival Lowell](#) (Fig 10) made extensive observations of Mars from 1893 to around 1908 at his observatory in Arizona and saw “canals” everywhere. He theorized that “an advanced but desperate culture had built them to tap Mars' polar ice caps, the last source of water on an inexorably drying planet”. Most of the scientific community was skeptical but the public ate it up, and controversies raged about the presence or absence of Martian canals and vegetation and oceans.

Even Nikola Tesla (Fig 11) became obsessed with

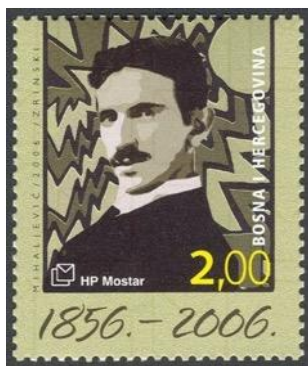


Figure 11. Bosnia-Croatia Admin., Sc 163, 2006

communicating with Mars after hearing in 1901 a signal from what he believed was the Red Planet!

The [History of Martian canals](#) relates that “In 1907 the British naturalist Alfred Russel Wallace (Fig 12) published the book *Is Mars Habitable?* that severely criticized Lowell's claims. Wallace's analysis showed that the surface of Mars was almost certainly much colder than Lowell had estimated, and that the atmospheric pressure was too low for liquid water to exist on the surface. He also pointed out that several recent efforts to find evidence of water vapor in the Martian atmosphere with [spectroscopic analysis](#) had failed. He concluded

along with one of his

drawings of the *canali*

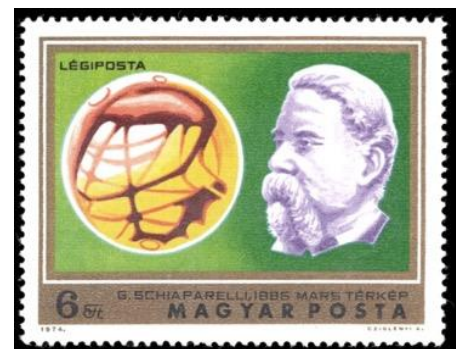


Figure 9. Hungary, Sc C347, 1974



Figure 10. Sierra Leone, Sc 1167e, 1990



Figure 12. Great Britain, Sc 2752, 2010

that complex life was impossible, let alone the planet-girding irrigation system claimed by Lowell.”



Figure 13. Hungary, Sc 2276, 1974

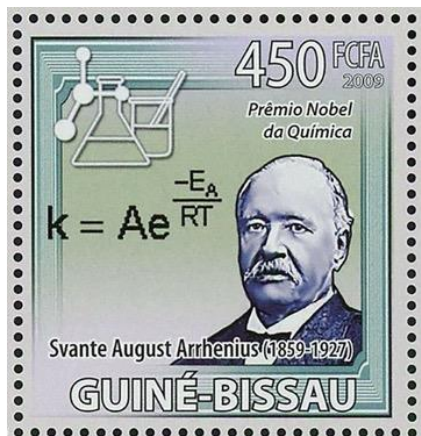


Figure 14. Guinea-Bissau, Mi4232, 2009

water and vegetation was tenacious, and was put out of its misery only with the flyby of [Mariner-4](#) in 1965 (discussed below).

Despite the controversy, Earth-based Mars science kept creeping forward. For example, the astronomer Gerard Kuiper (Fig 15), who is often said to be the “father” of modern planetary science, did some research on the Red Planet. In 1947 he predicted (correctly) that CO₂ is a major component of the Martian atmosphere (we now know that it is about 95% CO₂ - the [Atmosphere of Mars](#) has this and many other details about the Martian atmosphere). In 1956 he showed that Mars’ polar ice caps are composed of water ice rather than CO₂ ice (the caps *are* primarily composed of water ice but we now know that they are topped with thin layers of dry ice that solidifies onto the water ice in the Martian winter (the [Martian polar ice caps](#) has this and many other details).



Figure 15. Monaco, Sc 2387, 2005

As with most scientific areas, the Space Age accelerated the pace of Mars research. Planetary spacecraft were by far the most common tool, but other Earth-based tools were

Large telescopes were built in the early 20th century. When the new 1.52 m telescope on Mt. Wilson was aimed at Mars in 1909, there was no trace of the canals (Fig 13 shows one of the large Mt. Palomar telescopes in the context of Martian observations). Astronomers using other large telescopes around the world saw no canals either.

In around 1910, the Swedish chemist and Nobel prize winner Svante Arrhenius (Fig 14) argued that liquid [brines](#) could exist on Mars because they freeze at much lower temperatures than regular water. In the Martian winter, the brines would freeze and take on a lighter color, like water ice, but in spring and summer they would darken due to moistening by the melting brine. No biological life would be necessary for such a process to occur.

In the 1920s, spectroscopic observations at the Lowell Observatory measured an average Mars temperature of -40 °C (Earth’s average is +15 °C). The average near the poles was around -70 °C, and the equator was at about +10 °C. Those values are mostly too cold for running water. Nevertheless, the idea of canals and running

also developed. In 1965, Kuiper pioneered the use of a Convair-990 aircraft with an onboard IR telescope that observed the planets, Sun and stars at around 12 km altitude. An updated platform, using a converted C-141A aircraft, was named the [Kuiper Airborne Observatory](#) in his honor in 1974. This in turn led to the [SOFIA research aircraft](#), which was used in 2016 to measure [upper limits on methane \(CH₄\) in the Martian atmosphere](#). Stratospheric balloons were also used to observe Mars. One example is the Stratoscope-2 balloon flight that took place on 1 March 1963 (Fig 16). Some limited [Earth-based radar images of Mars](#) were obtained, starting in 1988, from the VLA (Very Large Array), Goldstone, and Arecibo Observatories. The radar sounders on some Mars spacecraft have provided much better data, though.



Figure 16. Stratoscope-2 Balloon Flight, 1 March 1963, Goldcraft Cachet Cover

The [NASA list of spacecraft missions to Mars](#) is a good starting point for Mars missions. The [Planetary Society also has a list](#), which points out that “Today, there are more spacecraft operating at Mars than any planet besides Earth – from orbiters to landers and rovers. Mars has been historically unkind to our attempts to send spacecraft there, with roughly half of all Mars missions failing. That percentage has improved in recent years”. The earliest missions in the 1960s and early 1970s were mostly failures, particularly for the Soviet Union (in contrast to their many successful Venus missions). NASA had some failures as well, but there were notable achievements in the [Mariner program](#).

On 15 July 1965, [Mariner-4](#) (Fig 17) became the first probe to make a successful flyby of the Red Planet. Its photographs (the first of another planet from space) showed no trace of Martian canals or vegetation. It estimated a surface pressure of 4 to 7 hPa (on Earth, it is around 1000 hPa) and a temperature of -100 °C. The spacecraft also detected almost no magnetic field or radiation belts, implying that the Martian atmosphere and surface must be exposed to the solar wind and cosmic radiation.

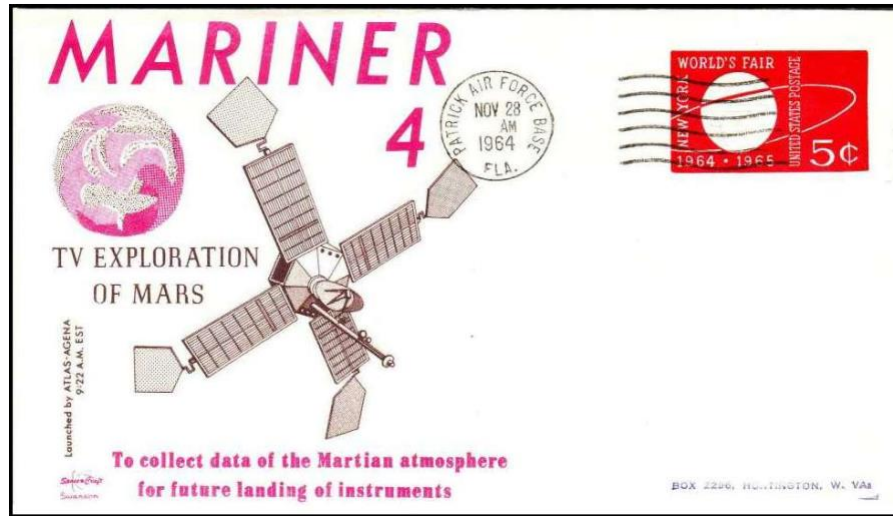


Figure 17. *Mariner-4* launch cover, 28 November 1964. Spacecraft-Swanson Cachet.

The space scientist James Van Allen and his colleagues wrote that those *Mariner-4* data “suggest that the solar wind will, on occasion and perhaps usually, have a direct interaction with the Martian atmosphere. This interaction may be of essential importance in determining the physical state of the atmosphere. Also, it is evident that the Martian atmosphere and surface are exposed to the full effects of solar and galactic cosmic radiation, irrespective of latitude” (Ref 2). The reader who wishes to know more about space weather in a philatelic context can refer to Ref 3. Sections 4.2 and 6.3 of that work focus on Mars.



Figure 18. Ascension, Sc 147, 1971

Mariner-6 and *-7* (Fig 18 shows “Mariner-VII”) were identical spacecraft that flew by Mars in 1969 and extended the work done by *Mariner-4*. [Mariner-6](#) found that the atmosphere was about 98 % CO₂, the surface temperatures ranged from -73 °C to -125 °C, and the surface pressure was 6-7 hPa. It photographed the south polar ice cap and found that it emitted IR radiation consistent with solid CO₂.

Mariner-8 and *-9* were also twins, but *Mariner-8* failed. [Mariner-9](#) (Fig 19) however performed flawlessly and became the first spacecraft to orbit another planet on 13 November 1971 (the Soviet [Mars-2](#) entered Mars orbit on 27 November 1971, and then *Mars-3* on 2 December 1971). When those three spacecraft arrived, a planet-wide dust storm was raging. *Mars-2*'s lander became the first human-made object to reach the Martian surface, but in a crash landing. The *Mars-3* lander did land but failed after 20 seconds. Both failures were possibly related to the dust storm. The two Soviet orbiters were able to return some scientific data, though. *Mariner-9* was re-programmed to begin its primary mission (the mapping of 70% of the Martian surface) after the dust storm subsided.



Figure 19. Micronesia, Sc 344i, 1999



Figure 20. Sierra Leone, Sc 1169a, 1990

During his Martian observations, Schiaparelli had noticed a bright spot that remained visible even during huge dust storms. He therefore concluded that it must be a high-altitude feature and named it *Nix Olympica* (Olympic Snows) because of the inference that it was snow-covered. After it was observed by *Mariner-9* to be a high and dry mountain, it was renamed *Olympus Mons* (Mount Olympus) (Fig 20). [Some of the features observed by Mariner-9](#) “included ancient river beds, craters, massive extinct volcanoes,

canyons, layered polar deposits, evidence of wind-driven deposition and erosion of sediments, weather fronts, ice clouds, localized dust storms, morning fogs and more” along with “a lack of evidence for volcanic activity, irregularities in Mars' gravity field, properties of the daytime ionosphere, atmospheric pressures ranging from 2.8 to 10.3 hPa, measurements of atmospheric water vapor content, altitude measurements, detection of seasonal upper atmosphere ozone, and an ultraviolet spectrum of Phobos”. The enormous [Valles Marineris](#) canyon system was named after *Mariner-9* to honor its achievements.

The *Mariner-9* mission results paved the way for NASA’s ambitious Viking program, in which a pair of Mars orbiters and landers, [Viking-1 and Viking-2](#), arrived at the planet in 1976, with both landers separating from their orbiters and successfully making their way



Figure 21. Guinea-Bissau, Sc C11, 1977

down to the surface. The landers “transmitted images of the surface, took surface samples and analyzed them for composition and signs of life, studied atmospheric composition and meteorology, and deployed seismometers ... [the] measured temperatures at the landing sites ranged

from 150 K to 250 K (-123 °C to -23 °C), with a variation over a given day of 35 K to 50 K (35 °C to 50 °C). Seasonal dust storms, pressure changes, and transport of atmospheric gases between the polar caps were observed.” The orbiters “imaged the entire surface of Mars at a resolution of 150 to 300 meters, and selected areas

at 8 meters.” A *Viking* orbiter, with the lander still attached, is depicted in Fig 21. The *Viking-2* orbiter snapped the first-ever color image of a regional Martian dust storm on 22 February 1977. Indicated by the arrow in Fig 22, it was about 300 km wide. Fig 23 depicts a *Viking* lander, with various components identified in the stamp, including a “capteur de température” (a temperature sensor) on one of the footpads. It was part of the *Viking* atmospheric structure experiment and was designed to measure temperatures during the lander’s descent phase, and then to estimate the soil temperatures after the landing. Each lander also had a [weather station](#): a meteorology boom with sensors for pressure, temperature, and wind speed and direction. It is visible, extending upward from the right side of the lander, in the right margin of Fig 23.

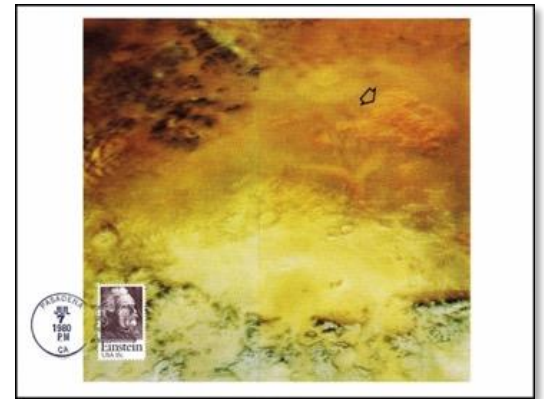


Figure 22. USA, Sc 1774 cover, 1980



Figure 23. Niger, BL459, 2015

There were no further Mars missions until the late 1980s, at least in part because planners were struggling to reduce their costs. Then there were multiple failures: the Soviet [Phobos-1](#) and [Phobos-2](#) (1988 launch), NASA’s [Mars Observer](#) (1992 launch), the Russian [Mars-96](#) (1996 launch), NASA’s [Mars Climate Orbiter](#) (MCO, 1998 launch), the Japanese [Nozomi](#) (1998 launch), and NASA’s [Mars Polar Lander](#) (MPL, 1999 launch, with Deep Space-2). The science goals of MCO and MPL had been to study the weather, climate, and water and carbon dioxide budgets of Mars to improve the understanding of the reservoirs, behavior, and atmospheric role of [volatiles](#), and to get some idea of historic Martian climate changes.

There were, however, two successful NASA Mars missions in the 1990s. The first was the [Mars Global Surveyor](#) (MGS, 1996 launch, Fig 24), whose “science objectives involved high resolution imaging of the surface, studies of the topography and gravity, the role of water and dust on the surface and in the atmosphere of Mars, the weather and climate of Mars, the composition of the surface and atmosphere, and the existence and evolution of the Martian magnetic field.” Many of the instruments on the failed *Mars Observer* were updated and re-flown on MGS.

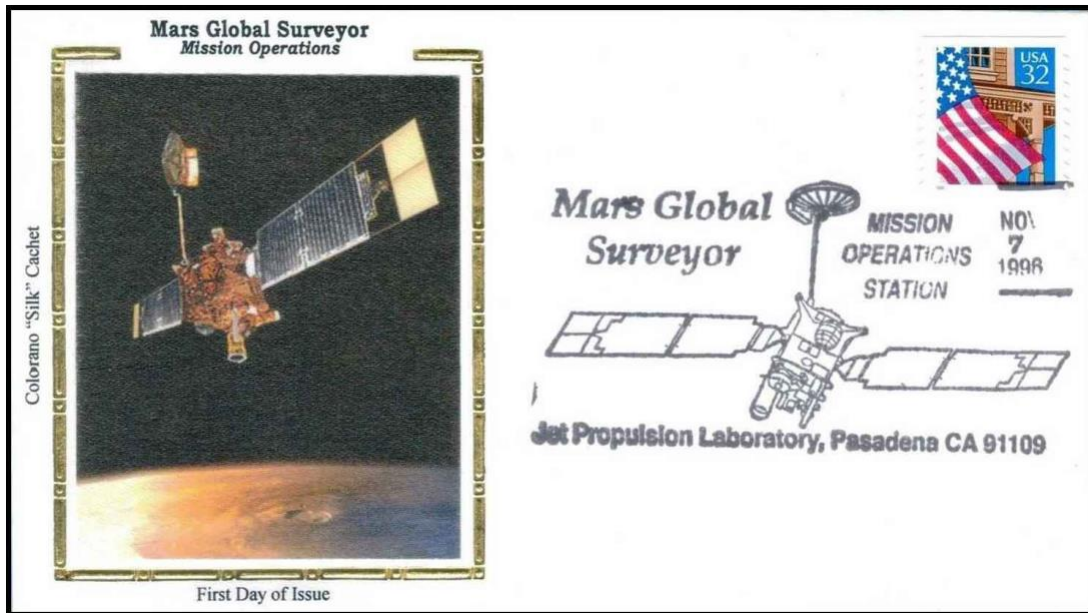


Figure 24. *Mars Global Surveyor* (MGS) launch cover, 7 November 1998. Colorano Silk Cachet

Then the [Mars Pathfinder](#) lander reached the Martian surface in 1997 on the ancient flood plain *Ares Vallis*. It carried Sojourner (Fig 25), the first rover outside the Earth-Moon system (two Soviet [Lunokhod rovers](#) operated on the Moon in the early 1970s). “The mission carried a series of scientific instruments to analyze the Martian atmosphere, climate, and geology and the composition of its rocks and soil”.

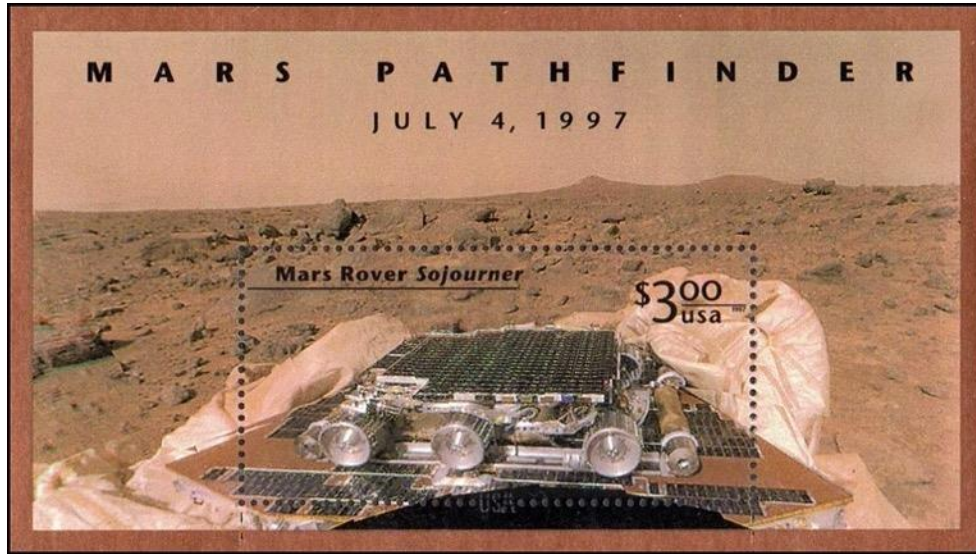


Figure 25. USA Sc 3178, 1977

The lander included the [Atmospheric Structure Instrument/Meteorology Package \(ASI/MET\)](#), which acted as a Mars meteorological station, collecting data about pressure, temperature, and winds. The 1.1 m long MET boom included three thermocouples for temperature measurement (at 25, 50 and 100 cm above the surface) and a hot wire anemometer on its top. The MET boom is visible in the drawing of the *Pathfinder* lander in the upper margin of the minisheet of 6 in Fig 26. It is indicated by a red arrow. Dust devils were detected, indirectly, by their effects on temperature, wind, and pressure. There were also hints of early morning ground fog. Sudden temperature fluctuations in the mornings suggested that sunshine warms the surface, with heat then moving upward into the atmosphere via small convective eddies. That happens on Earth as well.

The *Pathfinder* mission plays a supporting role in Andy Weir's 2011 novel *The Martian*, and in its 2015 film adaptation, in which astronaut Mark Watney, stranded and alone on the Red Planet, finds the long-dead lander and resuscitates it enough to use it to communicate with Earth.

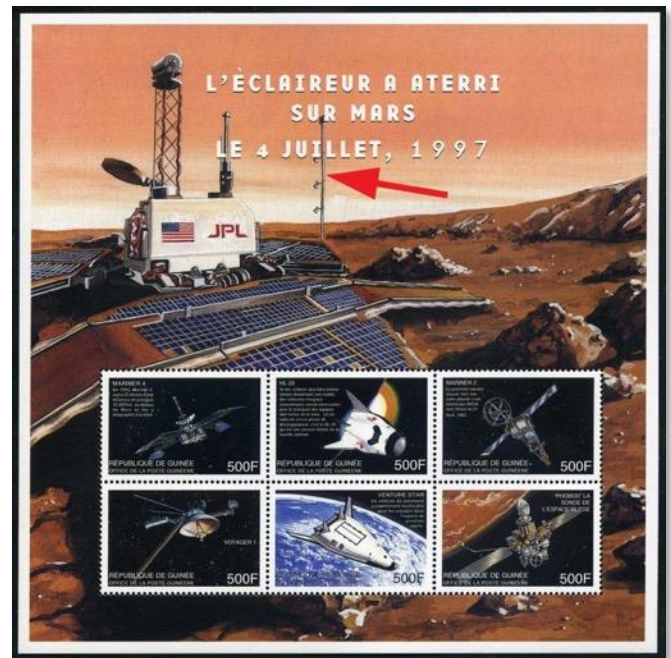


Figure 26. Guinea, Sc 1614, 1999 (red arrow point to MET boom)

This article has summarized how the Red Planet has been observed from early times through the spacecraft missions of the 20th century. The follow-up article about Mars, *Planetary Environments Part 6: Mars in the 21st Century*, will appear in the next issue of *Astrofax*.

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Ref. 1: Drake, Nadia, 2021: Our Obsession with Mars. *National Geographic*, March 2021, pp. 38-63.

Ref. 2: Van Allen, J. A., L. A. Frank, S. M. Krimigis and H. K. Hills, 1965: Absence of Martian radiation belts and implications thereof. *Science*, Vol. **149**, No. 3689 (10 Sept. 1965), pp 1228-1233.

Ref. 3: Toth, G, and D. Hillger, 2017: *Space Weather: A Philatelic Journey*. American Topical Association (ATA) Handbook 166 (paper version) or 166E (CD version), (December 2017).

About the Authors

Garry Toth, M.Sc., now retired, worked many years with the Meteorological Service of Canada. Correspondence to gmt.varia@gmail.com is welcome.

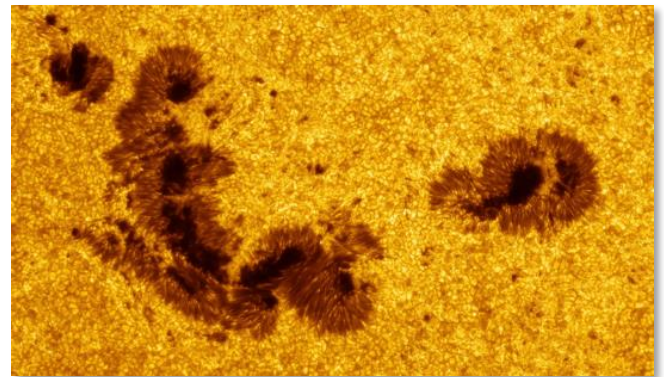
Don Hillger, Ph.D., now retired, was a research meteorologist with the National Oceanic and Atmospheric Administration (NOAA) and held a cooperative position at Colorado State University. Correspondence to don.hillger@colostate.edu is welcome.

We have researched and written extensively about weather, climate, and unmanned spacecraft on stamps and covers, as well as some other topics. See our complete [list of our publications](#), with electronic reproductions.

The May 2024 Solar Storm and Aurora Outbreak (and Aurora Philately)

By Gene R. Major

Just this past May 2024, many of our readers were fortunate to see a magnificent display of the aurora. Aurorae were seen far into the equatorial regions in both Northern and Southern hemispheres. The culprit behind this particular display was a massive series of solar flares from a huge sunspot group. The intensive auroral activity was caused by an X1.0 class and several M-class flares from solar Active Region AR3664 [as of this writing, the region is still very active and has been renamed AR3697, with the potential of producing flares and CMEs resulting in more aurora]. On 9 May, the active region produced an X2.25- and X1.12-class flare each associated with a full coronal mass ejection or CME. The Sun is currently in a high activity phase as part of Solar Cycle 25 (<https://earthsky.org/sun/solar-cycle-25-more-active-powerful-than-predicted/>).



Active Region AR3664, 8 May 2024 [MalVeaux]