Mars

THE RED PLANET

Beyond its silence and desolation, Mars hides secrets that hint at a very different and dynamic past

Written by
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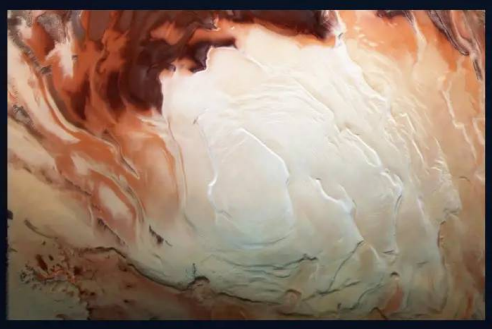
Mars has captivated stargazers for centuries. Its iconic red ochre surface, mysterious shifting sands and intriguing topological features fired the imagination of early astronomers and inspired wondrous tales of advanced alien civilisations. These days, with decades of solid scientific research to rely on, we are piecing together the true story of our fascinating neighbour to reveal some amazing things. Mars' story concerns more than just its own history, though. It is an interplanetary tale, interwoven with the yarn of humanity's incredible efforts to explore and learn about its dusty, barren wastes.

Mars has some things in common with our homeworld: it is a terrestrial planet, comprising a metallic core, silicate-rich mantle and solid crust, and the 24.65 hours it takes to complete a full rotation on its axis makes Martian days (called sols) of similar length to Earth's. The Red Planet also has seasons, but they are longer and less evenly distributed than ours because Mars spends almost twice as long travelling around the sun (687 Earth days) on a more elliptical orbital path. Other fundamental differences between the planets include size and temperature: Mars is only about half as big as Earth and much colder, with its lows plummeting to a frigid -153C (-225F). Due to their differing orbits and speeds, the distance between Earth and Mars is always fluctuating, but it averages approximately 140 million miles (225 million km). By current estimations, it would take humans between six and nine months to travel there.

That might be possible in the not-too-distant future, but until now, we have depended on unmanned missions to collect the wealth of information we know about Mars. Since the NASA spacecraft Mariner 4 made the first successful flyby of the planet in July 1965, space agencies have sent an assortment of orbiters, landers and rovers to the Red Planet to find out more about it. Equipped with sophisticated sensing equipment, an impressive array of instruments and state-of-the-art image-capturing technology, they have been able to fill in many of the gaps in our knowledge. Their data has helped paint a picture of a planet with formidable features, brutal environmental conditions and surprising geological characteristics.

In 1971, when Mariner 9 reached Mars, it set a new benchmark for space exploration by being the first craft to orbit another planet. It charted 85 per cent of Mars' surface and transmitted thousands of images back to NASA technicians. What Mariner 9 captured was astounding: a world defined by vast plains and massive plateaus – one pockmarked with enormous volcanoes, immense impact craters, and riven by deep canyons, lava tubes and other channels. The orbiter's images even showed Mars' two small, irregularly shaped moons, Phobos and Deimos.



LEFT Mars has polar ice caps. The southern cap is covered with a permanent layer of frozen carbon dioxide

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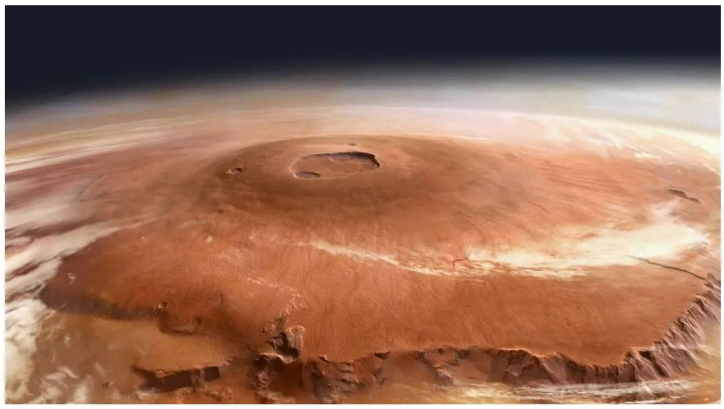
As the number of missions to Mars increased, it became evident that the Red Planet is much more interesting than we once thought. It is home to our Solar System's tallest mountain (Olympus Mons), its longest canyon system (Valles Marineris) and one of its largest impact basins (Hellas Planitia). Now, NASA's Mars Reconnaissance Orbiter enables us to see these and other areas in staggering detail through its powerful HiRISE (High Resolution Imaging Science Experiment) camera. The clarity of HiRISE's images seems to put Mars' surface within arm's reach of viewers, but to understand more about the planet, we also needed to land there and investigate from the ground.

Unfortunately, with its low gravity (38 per cent of Earth's), carbon dioxide-dominated atmosphere, hazardous radiation and fierce dust storms – which sometimes cover the whole planet – Mars' inhospitable environment makes it extremely difficult for human habitation. That's where the deployment of a small armada of robotic vehicles has proved invaluable. Starting with NASA's Mars Pathfinder mission in 1997, rovers have been scouring the Red Planet to gather data and undertake various investigative tasks that would be impossible for us. Although other vehicles, called landers, had touched down on the Martian surface earlier, they were stationary and limited to collecting samples in situ. The mobility of mechanical rovers was a game-changing development in the exploration of Mars, as it boosted our knowledge at a much faster rate.

In addition to taking excellent photographs of the Martian surface, rovers can study its rocks and regolith (broken rock, soil deposits and the iron oxide dust that gives Mars its red colour). Upon landing in 2004, the NASA rovers Spirit and Opportunity set out on a mission that would result in a remarkable discovery. They found

OLYMPUS MONS: A VOLCANIC GIANT

Topping out at around 22,000 metres (72,000 feet), the biggest mountain in the Solar System is almost three times taller than Mount Everest. The gigantic shield volcano, whose base area would cover most of France, is so huge that it pokes out of Mars' thin atmosphere and into space, despite its slopes only having a leisurely five per cent average gradient.



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MISSIONS TO MARS

Mars is the most explored planet beyond Earth, having been the target destination of more than 50 missions. A success rate of about 50 per cent highlights the difficult nature of the task. The United States' NASA has led the way, but other space agencies in Russia, Europe, India, the United Arab Emirates and China have all sent spacecraft to the Red Planet.

LEFT The Martian surface is explored by NASA rovers searching for signs of life

BELOW Mars' rocks provide clues to the Red Planet's distant and watery past

types of rocks and minerals with compositions that only form in watery environments, providing conclusive proof that the Red Planet's desert landscape was once wet. Together with mapping and mineral distribution data collated from orbiters, the rovers' ground-based work revealed that ancient Mars used to have river systems, lakes and perhaps even a huge ocean. Four billion years ago, the Red Planet was a very different place. So what happened?

As with Earth, the churning of Mars' superheated core used to produce a protective magnetic field around the planet, shielding it from the deadly effects of solar winds and radiation. This magnetosphere prevented Mars' atmosphere, which was much thicker and denser than it is now, from being stripped into space. It also ensured that there was enough atmospheric pressure for a large quantity of liquid water to exist on the surface. Sadly for Mars, the planet's core cooled faster than ours; it eventually lost its heat and the ability to maintain its magnetosphere. It could therefore no longer hold on to its thick atmosphere or surface water, which evaporated.

Not all of the water on Mars disappeared, however; some remains frozen at the planet's poles, while more exists beneath the surface, safe from the Solar System's cosmic onslaught. Both of Mars' polar regions are covered with thick ice caps that consist of water ice and frozen carbon dioxide. Although they shrink and expand throughout the Martian year, owing to seasonal variations, they are permanent fixtures. Data from seismic studies conducted in the Elysium Planitia region by NASA's InSight Lander has shown that water lies trapped in the cracks of porous rocks deep underground. Some experts believe that in all its forms, there is still enough water locked away on Mars to submerge the whole planet.

The realisation that ancient Mars was once awash with flowing water has provided scientists with extra impetus to find the answers to our biggest questions. Could life have existed on the Red Planet? Does it exist there now, hidden out of reach? We don't know, but the discovery of water increases the possibility, and the search continues in earnest. NASA's current operational rovers, Curiosity and Perseverance, are playing their part by investigating a pair of promising craters. Curiosity is examining whether past environmental conditions were conducive to microbial life, while Perseverance looks for indicators of biological origin called biosignatures. Like robotic archaeologists, they dig and collect samples to establish whether Mars was once habitable. How long will it be until they uncover something that changes our perception of the Solar System?

Despite all we have learnt, the full story of the Red Planet has yet to be told. It remains a mystery – one that has benefited from the previous limitations of our technology and the silent void of space that separates it from Earth. Today, though, the creations of some of our brightest minds venture forth undeterred. The geological echoes of the past they have recovered from Mars' irradiated regolith so far have given us tantalising glimpses into the planet's history and development. Such exciting breakthroughs can only embolden our ambition and steel our resolve to keep on exploring. And who knows, through further study, we may learn enough to help ensure that our home doesn't end up as dead and desolate as our Martian neighbour, or even how we might survive there ourselves some day.

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