Life on Mars

The current NASA mission to Mars is one of the most technologically advanced endeavours that mankind has ever attempted. As Lee Bardon describes, scientists at the University of Leicester have played a key role in this mission to discover life.

As a prominent object in the night sky, Mars has fascinated cultures on Earth for millennia.

Often, humanity associated the blood-red hue of the Red Planet with violence and war. The Greeks named the planet after their god of war, Ares; the ancient Egyptians called it Har dècher, or "The Red One", while the Roman Empire named it after their dignified war god, Mars; a name which has stuck to the present day.

Today, science seeks to offer yet more colourful stories to those offered by the folklore of the past. With the Mars Science Laboratory, NASA hopes to contribute yet another chapter to that story, and, if all goes according to plan, the most substantial science chapter to date.

The Mars Science Laboratory (MSL), the Curiosity rover, was built at NASA's Jet Propulsion Laboratory and is the most ambitious and sophisticated interplanetary mission ever attempted. It is engineered to roll over obstacles up to 65cm tall, and can range over 200 metres per day. It's equipped with such an unprecedented array of specialist instrumentation that even a non-space-geek can't help but find it all just a little bit exciting.

As impressive as the instrumentation is, however, the most exciting aspect of MSL is its mission objective itself. For centuries, the planet Mars has been inextricably linked to one of humanities deepest, most fundamental and persistent questions: are we alone in the universe?

Leicester's role

The University of Leicester has a long and distinguished history in space science and instrumentation research. This has ranged from helping to prove the existence of black holes, and maintaining an instrument in space every year since 1967. So, it is in keeping with this pedigree that Leicester planetary scientist Dr. John Bridges is involved in the MSL mission science team from across Europe as one of only two UK Participating Scientists.

Dr Bridges has been researching Martian meteorites and satellite data for the last 15 years, and supervises a number of PhDs across a range of topics about Mars, the early solar system and space science instrumentation. His personal goal for the mission is to link studies of Martian meteorites at Leicester University with what Curiosity finds on the surface of the planet, and to identify the conditions associated with hydrothermal fluids in the Martian crust.

Before his official appointment as Participating Scientist prior to launch in November 2011, Dr Bridges was involved in landing site selection, and has long since championed the Gale Crater landing site as a place of great geological and astrobiological interest.

Location, location, location

As it approaches the red planet with an almost incomprehensible speed of around 13,000 mph, Curiosity's large mass and Mars' thin atmosphere meant that the heat shield, parachute and airbag system alone would have been inadequate to provide sufficient protection from the heat of entry.

Instead, to allow for a rather more controlled and accurate descent into the landing site, a revolutionary new device called a 'Skycrane' was developed. Skycrane, a special descent vehicle equipped with rocket motors on eight of its corners, allowed for the rover to be gently placed onto the surface at a leisurely speed of 0.6 metres per second, before explosives cut the cables between rover and descent stage, allowing the latter to safely crash elsewhere.

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The chosen landing site is located within Gale Crater, at the foot of a three mile high mountain named Mount Sharp, in commemoration of geologist, and one of the forefathers of planetary science, Robert P. Sharp. It consists of a flat, elliptical area measuring approximately four by twelve miles, playing a part in the successful touchdown by allowing a certain degree of manoeuvre insurance via the provision of a relatively flat surface. However, the decision to land in this area was not only in the interests of the engineers: the area is rich in scientific intrigue, and of paramount importance to the mission objectives.

Gale Crater formed when Mars was impacted by a meteor 3.5 to 3.8 billion years ago. This in itself is unusual. A large mountain in the middle of an impact crater seems somewhat counter-intuitive: wouldn't it have been flattened during the event? Over the billions of years that have lapsed since the impact, current theory suggests that the mountain itself formed slowly, sometimes from sediment deposited by the relentless Martian wind currents, and sometimes through gradual deposition at the bottom of a large lake. As such, the mountain may represent not only one of the largest exposed sections of layered sedimentary rock on Mars, but in the solar system itself. Locked within those layers of sedimentary rock is billions of years' worth of invaluable information regarding the planet's environmental past.

The Search for life

Data from various sources suggest that Mars was once host to vast lakes and rivers. Clay signatures are found near the bottom of the Mount Sharp, while sulphate minerals are found near the top, both of which on Earth only form in the presence of liquid water. It is hoped that any organic molecules or materials that may have existed on Mars, will be entombed within these clays, and that Curiosity will find them as it prospects the gentle slopes at the base of Mount Sharp.

Given the difficulty in finding similar preservations on Earth, however, even during a time when it is known to have been teeming with life; this may not be possible. What is possible are tests that give an indication of the temperature and acidity or alkalinity of the water that once flowed through Martian rocks, and whether it was toxic to microbial life.

Curiosity has been equipped with a myriad of impressive instruments that will enable it to perform the appropriate analyses. One of the most exciting instruments on Curiosity is ChemCam: a spectroscopic device that uses a laser to clear dust away from Martian rocks at a range of up to 23 feet, to analyse the chemical composition of the rock, and, using the remote cameras attached to the mast, to provide detailed images. This will allow the science team to decide which rocks are the most suitable for more in-depth analysis with other instruments such as CheMin.

CheMin, or, the Chemistry and Mineralogy X-Ray Diffraction Instrument, is tasked with drilling into rocks to collect powdered samples along with Martian soils. It assesses the abundances of minerals present in the sample. SAM, the Sample Analysis at Mars instrumental suite, then searches for organic compounds and explores their generation and destruction in the Martian

atmosphere.

Curiosity's capabilities don't end there, however. It is also host to a range of spectrometers to analyse every aspect of the conditions on Mars. Curiosity has even been endowed with an instrument to prepare for future human exploration of Mars. RAD, or the Radiation Assessment Detector, identifies and measures the high-energy radiation at the Martian surface, allowing scientists to determine the potential effect of this radiation on astronauts.

This abundance of high-tech equipment will assist the team of participating scientists currently located at NASA's Jet Propulsion Lab in Pasadena, in addressing a number of questions. The primary research goal of Dr Bridges' team is to understand the conditions associated with past liquid water on Mars. With this data we will be able to answer whether Martian liquid water was present in surface lakes for millions of years, or whether it was somewhat more fleeting. In using its many instruments to probe the composition of minerals encountered during the mission, it will thus be determined whether Mars was, at any stage in its history, habitable to microbial life as we know it.

Since scientific exploration of Mars began, we have learnt much about our closest neighbour. We know, for example, that its colour is not the result of epic and bloody extraterrestrial battles, but of surface iron oxide dust. We know its history also tells of great upheavals, geological and climactic battles lost and won, and floods that would have panicked Noah. Yet, the MSL mission brought us closer to the finding out the biggest question of all: whether life, in its simplest form, is a common or rare feature of the universe.

In doing so, it will allow for further understanding of the tumultuous history of a planet brimming with surprises, and which has been close to the heart of humanity since we first gazed at the night sky in wonder. If all goes according to plan, MSL will continue the ever unfolding story-of-everything. This is regardless of whether the data indicates a positive or negative likelihood of life having occupied the Martian soils of antiquity. Even if the worst were to occur, and Curiosity is crippled by a malfunction, a freak accident, or a passing Dalek, before much data can be collected, the engineering successes of its Entry, Descent, and Landing Configuration system have already provided us with an initial instalment of viable technology for what could become the 'one giant leap' of our generation: the first manned mission to another planet. ■

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