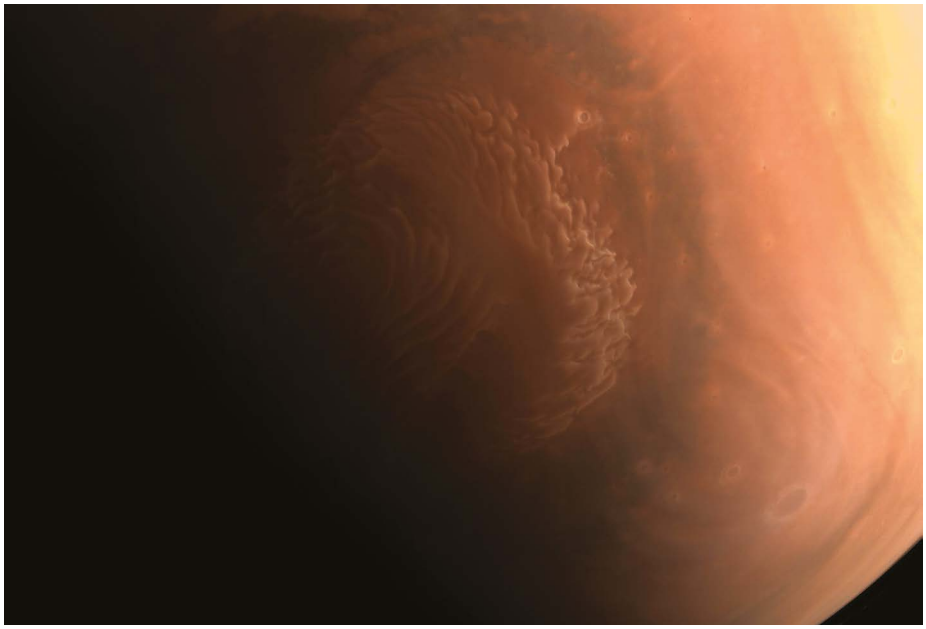


CNSA/XINHUA/ALAMY

The surface of Mars, photographed by China's Tianwen-1 probe in February.

WHAT CHINA'S MARS ROVER WILL DO NEXT

The landing of Zhurong was the biggest test yet of China's nascent deep-space exploration capabilities.

By Smriti Mallapaty

China's Tianwen-1 spacecraft, in orbit around the red planet, has dropped its lander and rover — named Zhurong after a Chinese god of fire — completing the most perilous stage of its ten-month mission.

According to Chinese state news agency Xinhua, an entry capsule enclosing the vehicles separated from the orbiter at about 4 a.m. Beijing time on 15 May, entering Mars's atmosphere at an altitude of 125 kilometres.

It then hurtled towards the surface at 4.8 kilometres per second, protected by a heat shield. As the probe closed in on Mars, it released a huge parachute and then used rocket boosters to brake. Once it reached 100 metres above the surface, it hovered and used a laser-guided system to assess the area for obstacles such as boulders before landing.

The craft's plummet through the Martian atmosphere was performed autonomously. "Each step had only one chance, and the actions were closely linked. If there had been any flaw, the landing would have failed," Geng Yan, an official at the Lunar Exploration and Space Program Center of the China National Space Administration (CNSA), told Xinhua.

This is China's first mission to Mars, and makes the country only the third nation — after the Soviet Union and the United States — to have landed a spacecraft on the planet. The mission "is a big leap for China because they are doing in a single go what NASA took decades to do", says Roberto Orosei, a planetary scientist at the Institute of Radioastronomy of Bologna in Italy.

Zhurong joins several other active Mars missions. NASA's Perseverance rover, which arrived on 18 February, is more than 1,000 kilometres away from Zhurong's landing site, and the agency's Curiosity rover has been exploring since 2012. Several spacecraft are also circling Mars, including the United Arab Emirates' Hope orbiter, which also arrived in February. "The more the merrier on Mars," says David Flannery, an astrobiologist at Queensland University of Technology in Brisbane, Australia.

Researchers say that the engineering feat of getting there has taken precedence over science in China's first tour of Mars, but the mission could still reveal new geological information. They are especially excited about the possibility that permafrost might be detected in Utopia Planitia, the region in the northern hemisphere where Zhurong has landed (see 'Landing site').

Biggest test yet

The Tianwen-1 mission included an orbiter, a lander and a rover — making it the first to send all three elements to the planet. The spacecraft departed Earth in July 2020 and arrived at Mars in February 2021, but the landing was the biggest test yet of China's nascent deep-space exploration capabilities.

In 1997, NASA's Mars Pathfinder sent its first rover, named Sojourner, to a rocky region of the planet. "We didn't get a lot of amazing science from that mission, but it paved the way for much more capable autonomous rovers, and now we are reaping the benefits of those missions," says Flannery, who works on Perseverance, NASA's fifth Mars rover.

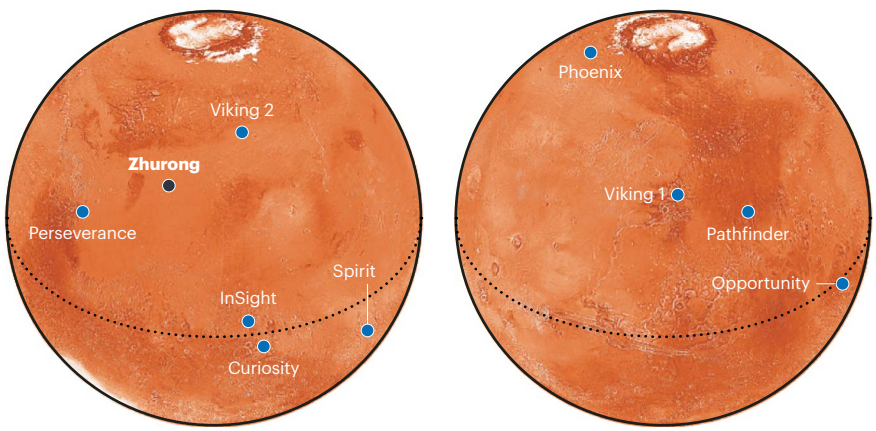
Within days, the six-wheeled Zhurong rover will trundle off the lander to explore for at least three months — but it could survive for years, as NASA's Spirit and Opportunity rovers did.

Utopia Planitia, where Zhurong now sits, is a wide, flat expanse in a vast, featureless basin that formed when a smaller object smashed into Mars billions of years ago.

The basin's surface is mostly covered in volcanic material, which could have been modified by more-recent processes, such as the

LANDING SITE

A Chinese rover called Zhurong has landed in Utopia Planitia in Mars's northern hemisphere. Soviet and US missions have landed in many regions of Mars.



repeated freezing and thawing of ice. Orosei says that studies of the region from Mars's orbit suggest that a layer of permafrost could be hiding just below the surface.

In 1976, NASA's Viking 2 mission landed farther north on Utopia Planitia. "It's a good place to try a first landing," Flannery said before the landing. The low altitude, clear terrain and potential for finding ice also means that future missions might be able to collect samples there, and that the region could make a good landing site for crewed missions, he says.

Measuring Mars

Zhurong is kitted out with a suite of instruments for exploring the Martian environment. Two cameras are fitted on a mast to take images of nearby rocks while the rover is stationary; these will be used to plan the journeys that it takes. A multispectral camera placed between these two navigation imagers will reveal the minerals present in these rocks.

Like Perseverance, Zhurong has ground-penetrating radar. This will reveal the geological processes that led to the formation of the regions through which it travels. With luck, Zhurong might detect the thin horizon that marks permafrost, says Orosei. Knowing how deep this lies, and its general characteristics, could offer insights into more recent climate changes on Mars, and reveal the fate of ancient water that once soaked the surface, he says.

If the researchers are really fortunate, they might even find some very ancient rocks, which could offer a window onto our own planet's history, says Joseph Michalski, a planetary scientist at the University of Hong Kong: most of the similar evidence here on Earth has been destroyed by plate tectonics, says Michalski.

Zhurong's spectrometer includes a laser-based technology that can zap rocks to study their make-up. It will also be the first rover equipped with a magnetometer to measure the magnetic field in its vicinity.

Orbital insights

From orbit, Tianwen-1 will communicate Zhurong's insights to Earth. But the orbiter — the name of which means 'questions to heaven' — will also make its own scientific contributions with its seven instruments, including cameras, ground-penetrating radar and a spectrometer.

A magnetometer and particle analysers will study the boundary between the higher Martian atmosphere and solar winds to better understand how Mars's magnetic field operates today. Combined with data from other orbiters studying the planet's upper atmosphere, this knowledge will offer researchers "a much better picture of what goes on around Mars", says Orosei.

A successful Mars landing could usher in more-advanced Chinese missions — including a sample-return initiative, which is planned to take place by 2030.

NASA REBOOTS ITS ROLE IN FIGHTING CLIMATE CHANGE

Space agency aims to breathe new life into its Earth-science programme.

By Alexandra Witze

NASA is best known for exploring other worlds, whether that's sending astronauts to the Moon or flying helicopters on Mars. But under US President Joe Biden, the space agency intends to boost its reputation as a major player in studying Earth — especially with an eye towards fighting climate change.

"Biden made clear that climate is a priority," says Waleed Abdalati, director of the Cooperative Institute for Research in Environmental Sciences in Boulder, Colorado. "There's a clear role for NASA to play in that," he says, given all the Earth-science research it funds and the Earth-observing satellites it launches.

In recent months, NASA has signalled its intention to reinvigorate its role in informing US climate policy, by appointing its first climate adviser and ramping up work on key missions to study how Earth's climate is changing.

The work is particularly crucial as climate change accelerates, agency officials say. "The demand for actionable information is going to increase pretty dramatically over the next decade or two," says Karen St. Germain, head of NASA's Earth-science division in Washington DC.

Among the many US federal agencies that Biden has conscripted to curb climate change, NASA stands out because it is a leader in basic planetary discoveries. Its history of Earth observation stretches back to 1960, when it launched the TIROS-1 satellite to test the feasibility of monitoring weather from space. Over more than six decades, NASA has designed, built and launched spacecraft to observe Earth as it changes. Often working in concert with the US National Oceanic and Atmospheric Administration (NOAA), which has primary responsibility for national weather forecasting, NASA runs satellites that measure ice sheets melting and carbon dioxide flowing through the atmosphere. The agency also flies aeroplanes to gather data about planetary change and funds a broad array of fundamental climate research, such as climate-modelling

CARL HOSTETTER/NASA EPIC TEAM

Earth as imaged by the DSCOVR satellite.