News in focus

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Chang'e-6 lifted off on board a Long March 5 rocket from the Wenchang Space Launch Centre on Hainan Island, southern China.

WHAT CHINA'S MISSION TO COLLECT ROCKS FROM THE MOON'S FAR SIDE COULD REVEAL

The Chang'e-6 mission aims to land in the Moon's oldest and largest crater, where it will collect rocks to bring back to Earth.

By Ling Xin

On 3 May, China successfully launched its historic Chang'e-6 lunar mission. The goal is to collect the rocks on the far side of the Moon, inside the South Pole–Aitken (SPA) basin, the largest and oldest impact crater on the lunar surface, and bring them back to Earth for analysis.

The stack of four spacecraft needed to complete this unprecedented and highly challenging mission blasted off from the Wenchang Space Launch Centre on Hainan Island, southern China, tucked into the nose of a 57-metre-tall Long March 5 rocket.

"The whole process is very complex and risky," says Jonathan McDowell, an astronomer at the Harvard–Smithsonian Center for Astrophysics in Cambridge, Massachusetts.

But he says it's a risk worth taking: "Samples from the SPA basin would be very interesting scientifically and tell us a lot about the history of the Moon and of the early Solar System."

Far-side science

Because the Moon is tidally locked to Earth, humans were able to see only its near side for thousands of years. In 1959, the first far-side images returned by the Soviet probe Luna 3 revealed a lunar face pocked with mountains and impact craters, in contrast to the relatively smooth near side. Since then, scientists have been collecting data from satellites orbiting the Moon to understand its rugged half. In 2019, China's Chang'e-4 became the first spacecraft to soft land and conduct surveys on the Moon's far side.

The Chang'e-6 mission, for which the landing site was carefully chosen by Chinese scientists and their international colleagues, aims to obtain the first measurements of the age and composition of the geology of the Moon's far side. These data could provide key clues as to why the two sides of the Moon are so different – known as the lunar dichotomy mystery – and help to test theories about the history of the Solar System.

The SPA basin is a vast indentation on the lower half of the far side and is some 2,500 kilometres wide and 8 kilometres deep. The mission team, led by deputy chief designer Chunlai Li at the National Astronomical Observatories in Beijing, has identified three potential landing areas in the basin's northeastern part. The researchers think the sites could have a variety of materials formed during repeated asteroid impacts and volcanic eruptions over two billion years, and could therefore be scientifically rich.

The most likely rock to be collected is basalt – dark-coloured cooled lava – which has previously been brought back to Earth for analysis from the Moon's near side. Scientists will be able to date the far-side basalt samples and assess their chemical composition, providing clues to the rocks' formation. "Then we can make comparative studies to understand why volcanic activities happened on a much smaller scale and ended much earlier on the far side of the Moon," says Long Xiao, a planetary scientist at the China University of Geosciences in Wuhan.

Being able to pin down the SPA basin's age would also be a huge achievement, says planetary geologist Carolyn van der Bogert at the University of Münster in Germany. It will help to settle the long-standing debate about whether the Moon and the inner Solar System were battered by a massive cluster of asteroids between 4.0 billion and 3.8 billion years ago. If the SPA basin is older, then it would cast doubt on the 'heavy bombardment' theory.

In addition to basalt, scientists hope that Chang'e-6 will pick up fragments of other rocks that have been scattered during impact events. If the Chinese mission strikes ejecta from the deeper lunar crust or mantle, it will have hit scientific gold.

Engineering challenges

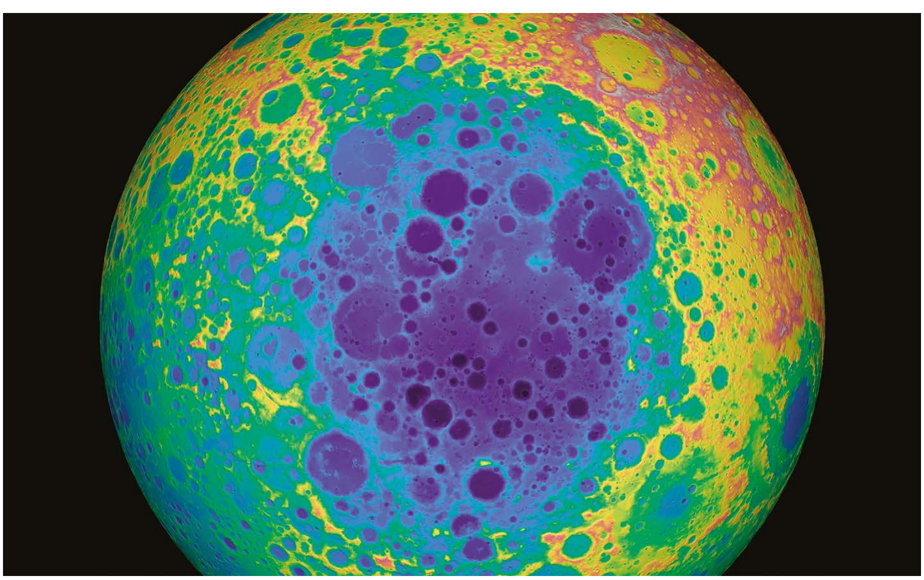
Chang'e-6 was originally built as a backup for the Chang'e-5 mission, which successfully returned 1.73 kilograms of samples from the Moon's near side in 2020. Because the two craft are identical, site selection for Chang'e-6's landing was constrained to latitudes similar those of Chang'e-5's and the area needed to have a relatively flat surface, says Li.

Like its predecessor, Chang'e-6 does not predetermine its landing site but will use its instrumentation during the descent to find the safest and most favourable spot. "The landing of Chang'e-6 would be more challenging than Chang'e-5 simply because the far-side landing site is more rugged," says Xiao.

"Samples from the SPA basin would be very interesting scientifically."

Chang'e-6, like its twin, consists of an orbiter, a lander, an ascender and a re-entry module. When the spacecraft arrives at the Moon, it will separate into two parts: the lander and ascender will head for the lunar surface while the orbiter and re-entry module remain in orbit.

If it pulls off the difficult soft landing, the lander will drill into the lunar surface and scoop up two kilograms of soil and rock. The sampling process needs to be completed within 48 hours, after which the ascender aims to blast off from the lander and return to the orbiter. There, it is supposed to dock and transfer the precious samples to the re-entry module for the trip home.



The South Pole–Aitken basin is the blue area in the centre of this false-colour image.

NASA/GSFC/UNIV. ARIZONA

During the sample-collection and lift-off process, the Chang'e-6 lander will be unable to communicate directly with Earth. Every command will need to go through a relay satellite named Queqiao-2. Launched in March and now operating in a highly elliptical orbit around the Moon, Queqiao-2 is more powerful than the Queqiao satellite used for the Chang'e-4 mission. Its 4.2-metre umbrella-shaped antenna can serve up to 10 spacecraft working on the Moon's far side.

International collaboration

Chang'e-6 is also carrying scientific payloads from France, Sweden, Italy and Pakistan. Researchers plan to use the Detection of Outgassing RadoN (DORN), which will be the first French instrument on the Moon, to analyse radon released from the lunar surface as a tracer to study the origin and dynamics of the Moon's faint atmosphere. Pierre-Yves Meslin, a planetary scientist at the Research Institute in Astrophysics and Planetology in Toulouse, France, says previous spacecraft have measured radon-gas movement from orbit, but surface-level information is a missing piece of the puzzle.

The Negative Ions at the Lunar Surface, a payload developed in Sweden with funding from the European Space Agency (ESA), will seek to answer the question of why no negative ions have yet been detected on the lunar surface. Negative particles could be short-lived, formed either by atoms at the surface snatching electrons from the solar wind, or by molecules breaking apart because of the solar radiation. The biggest challenge for this instrument is overheating, because it needs to face the Sun, says ESA project manager Neil Melville, who is based in The Hague, the Netherlands. But he says one hour of operation should be enough to gather the data.

Italy's National Institute for Nuclear Physics is sending a laser retroreflector for distance measurements. And Pakistan's first lunar satellite is piggy-backing on the Chang'e-6 orbiter, from which it will deploy after the spacecraft enters lunar orbit.

Both surface instruments will need to complete their work and send their data back within the 48-hour window, because the ascender shares the communications and control system with the lander. "Even if the instruments on the lander continue to take data, there is no way to receive them here on Earth," Li says.

He says that the Chang'e-6 specimens will be shared with the international community.

"When those samples come back to Earth, they will be like a Christmas present – whoever opens it will be happily surprised," van der Bogert says.