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Recovery personnel check the reentry capsule of the Chang'e 6 probe on Tuesday after it landed in Siziwang Banner in North China's Inner Mongolia autonomous region. The Chang'e 6 mission has brought back to Earth the first samples ever collected from the far side of the moon. **WANG FEI / FOR CHINA DAILY**

## Chang'e 6: Samples likely to offer crucial lunar data

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The Chang'e 6 probe, representing the world's first attempt to bring samples from the far side of the moon, was launched by a Long March 5 heavy-lift carrier rocket on May 3 from the Wenchang Space Launch Center in Hainan province. The 8.35-ton spacecraft was designed and built by the China Academy of Space Technology, a subsidiary of China Aerospace Science and Technology Corp, and consisted of four components — an orbiter, a lander, an ascender and a reentry capsule. After a host of sophisticated steps, the lander touched down at the South Pole-Aitken Basin, one of the largest-known impact craters in the solar system, on the morning of June 2. The landing marked the second time a spacecraft ever arrived on the lunar far side. The vast region had never been reached by any spacecraft until January 2019, when the Chang'e 4 probe landed in the South Pole-Aitken Basin. The Chang'e 4 surveyed areas sur-

rounding its landing site, but did not collect and send back lunar samples. The Chang'e 6 lander worked for 49 hours on the moon's far side, using a mechanical arm and a drill to collect surface and underground materials. Meanwhile, several items of scientific equipment were activated to conduct survey and analysis assignments. After the tasks were completed, the sample-loaded ascender lifted off from the lunar surface and reached lunar orbit to dock with the reentry capsule and transfer the samples. In the final leg of the mission, the orbiter-reentry capsule combination flew back to the Earth's orbit, before separating on Tuesday. The landscapes and physical characteristics of the lunar far side, which permanently faces away from Earth, are very different from those of the near side, which is visible from Earth, according to scientists. The new samples are expected to offer researchers around the globe useful clues to answer questions related to the moon, and it will likely bring a range of invaluable scientific payoffs, they said.

## Xi hails success of lunar mission

President says completion of Chang'e 6 probe to far side of moon a new milestone

By ZHAO LEI  
zhao lei@chinadaily.com.cn

President Xi Jinping sent a congratulatory message on Tuesday on the success of the Chang'e 6 mission, which for the first time brought scientifically precious samples from the moon's far side back to Earth.

On behalf of the Communist Party of China Central Committee, the State Council and the Central Military Commission, Xi, who is also general secretary of the CPC Central Committee and chairman of the CMC, extended warm congratulations and sincere greetings to the Chang'e 6 mission headquarters and all those who participated in the historic mission.

In his message, the president noted that the Chang'e 6 probe realized the world's first sample-return endeavor from the lunar far side, marking a new milestone in China's effort to become a global power in the space industry as well as in science and technology.

"Over the past 20 years, all comrades taking part in lunar exploration programs have been upholding the spirit of the cause, continuing to climb the peak of science and technology. You have made world-class achievements and established a high-quality, efficient path for

exploring the moon," Xi said. "Your extraordinary feats will be enshrined in the memory of our motherland and the people." The president expressed the hope that those who participated in the mission will make full use of the new samples in scientific studies and keep working on deep-space explorations and other major space projects. "You shall march toward building the country into a major power in space, achieving new feats in exploring the universe and benefiting humanity, and making new contributions to Chinese modernization and national rejuvenation," Xi said, also encouraging the mission's participants to continue strengthening international cooperation.

Carrying the unique lunar samples, the reentry capsule of the Chang'e 6 robotic probe touched down at 2:07 pm on Tuesday on its preset landing site in Siziwang Banner in the Inner Mongolia autonomous region, successfully completing a 53-day voyage that involved a host of complex and challenging maneuvers. The reentry and landing processes started at around 1:20 pm after the mission controllers at the Beijing Aerospace Control Center uploaded high-accuracy navigation data to the orbiter-reentry capsule combination. The capsule separated from the orbiter about 5,000 kilometers above the southern Atlantic Ocean and began to descend toward Earth.



Staff members at the Beijing Aerospace Control Center pose for a group photo on Tuesday upon the successful completion of the Chang'e 6 mission. **JIN LIANGKUI / XINHUA**

It entered the atmosphere at around 1:41 pm at a speed of 10.9 kilometers per second, close to the second cosmic velocity, and then bounced out of the atmosphere in a maneuver to reduce its ultrahigh speed. The second cosmic velocity, also known as the escape velocity, refers to the ultrafast speed required to escape the gravitational field of a celestial body. After a short while, the capsule reentered the atmosphere and kept gliding down. When the craft was about 10 km above ground, it released its parachutes and landed smoothly on the sandy grassland. The entire landing process was operated by the capsule itself with the help of its sensors and computers.

Shortly after touchdown, recovery personnel sent from the Jiuquan Satellite Launch Center arrived at the landing site in helicopters and off-road vehicles. The capsule is scheduled to be transported by an airplane to Beijing on Wednesday, where it will be opened by experts at the China Academy of Space Technology. The samples will be taken out of the capsule and weighed before being delivered. In due course, the National Astronomical Observatory, a subsidiary of the Chinese Academy of Sciences, according to the China National Space Administration.

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## Scientists find graphene flakes in lunar soil sample

By LIU MINGTAI in Changchun and LIANG SHUANG

Chinese scientists have discovered the presence of a special form of carbon in lunar soil retrieved by China's Chang'e 5 probe, offering new evidence about the geological evolution of the moon and providing clues for the future utilization of the substance. The research, published in the journal *National Science Review* last week, revealed the existence of naturally formed few-layer graphene, a substance consisting of carbon atoms in a special, thin-layered structure. The team, led by professors Zou Meng, Zhang Wei and senior engineer Li Xijuan from Jilin University, and Ren Wencui from the Chinese Academy of Sciences' Institute of Metal Research, analyzed an olive-shaped sample of lunar soil, about 2.9 millimeters by 1.6 mm, retrieved from the Chang'e 5 mission in 2020.

According to the team, scientists generally believe that some 1.9 percent of interstellar carbon exists in the form of graphene, with its shape and structure determined by the process of its formation.

Using a special spectrometer, researchers found an iron compound that is closely related to the formation of graphene in a carbon-rich section of the sample. They then used advanced microscopic and mapping technologies to confirm that the carbon on flakes in the sample comprised "ribbons" that have two to seven layers of graphene.

In tracing the graphene's formation, the team proposed that it may have formed in volcanic activ-

ity in the early stages of the moon's existence, and be catalyzed by solar winds that can stir up lunar soil and iron-containing minerals that helped transform the carbon atoms' structure. They added that impact processes from meteorites, which create high-temperature and high-pressure environments, may also have led to the graphene's formation. On Earth, graphene is becoming a star in materials science due to its special features in optics, electronics and mechanics. "If silicon was the strategic new material of the 20th century, graphene is that for the 21st century," Liu Zhongfan, an academician at the CAS, told *The Economic Observer* in April.

The team believes its study could help develop ways to produce the material inexpensively and expand its use. "The mineral-catalyzed formation of natural graphene sheds light on the development of low-cost scalable synthesis techniques of high-quality graphene," the paper said. "Therefore, a new lunar exploration program may be promoted, and some forthcoming breakthroughs can be expected."

By early this month, some 777 grams of the 1,731 grams of lunar samples retrieved by Chang'e 5 had been distributed to 114 research teams from 40 facilities, yielding some 70 studies published in major journals, according to the CAS' Institute of Geology and Geophysics.

Han Junhong contributed to this story.

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## Unearthing the moon's secrets, little by little

The Chang'e 6 mission is unique in being mankind's first mission to bring back samples from the far side of the moon. The success of the mission and its outcomes will doubtlessly contribute to a more comprehensive understanding of lunar evolution. Because the period of the moon's rotation is the same as that of its round trip around the Earth, more or less the same side of the moon faces the Earth all the time, which is called a tidal lock. Although US astronauts landed on the moon in the 1960s, it was not until 2018 that China's Chang'e 4, although unmanned, soft-landed on the far

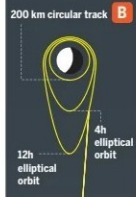
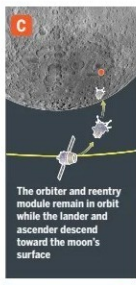
side of the moon. Later, in 2020, Chang'e 5 brought back lunar soil from the near side of the moon. Now, Chang'e 6 has surpassed those two earlier missions by bringing soil from the far side of the moon. While the area where Chang'e 5 landed, namely Mons Rümker, was formed 2 billion years ago, the samples collected by Chang'e 6 come from the South Pole-Aitken basin that's the largest, deepest, as well as the oldest crater basin not only on the moon but in the entire solar system. According to existing knowledge, collisions might have led to the creation of this crater on the moon's surface, which means

the lunar soil collected by Chang'e 6 could be 4 billion years old and reveal secrets of the solar system during that early period. That's around the time when the Earth had just come into being. In other words, soil samples from the far side of the moon may tell stories about not only the moon but also the Earth and the entire solar system. That China is the first country to have sent a mission to collect samples from the far side of the moon shows its technological capabilities. More questions about the moon will surely be answered as China has more missions planned.

—ZHANG ZHOUXIANG, CHINA DAILY



# CHINA MARVELS



## MOON LANDING HISTORY



## UNVEILING THE FAR SIDE

# A MOON ODYSSEY

Far side gets second 'Earthly' visitor as China's space program makes stellar leap with historic mission

By ZHAO LEI  
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China's Chang'e 6 unmanned mission has made history by providing the first-ever substances from the lunar far side to mankind.

Before the mission, all of the lunar substances on Earth were collected from the near side of the moon.

The landscapes and physical characteristics of the far side, which permanently faces away from Earth, are very different from those of the near side, which is visible from Earth, according to scientists.

The new samples will probably offer researchers worldwide useful clues for answering questions about our closest neighbor, and will likely bring a range of invaluable scientific payoffs, they said.

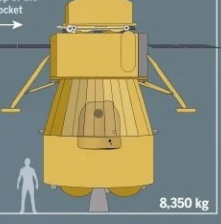
The 8.35-metric-ton Chang'e 6 spacecraft, consisting of an orbiter, a lander, an ascender and a reentry capsule, was launched by a Long March 5 heavy-lift carrier rocket on May 3 from Wenchang Space Launch Center in Hainan province. It entered lunar orbit on May 8.

After a series of sophisticated steps, the lander touched down in the South Pole-Aitken Basin, one of the largest known impact craters in the solar system, on the morning of June 2.

It worked 49 hours on the lunar far side, using a mechanical arm and a drill to collect surface and underground materials. Meanwhile, several scientific instruments were activated to conduct surveys and analyses.

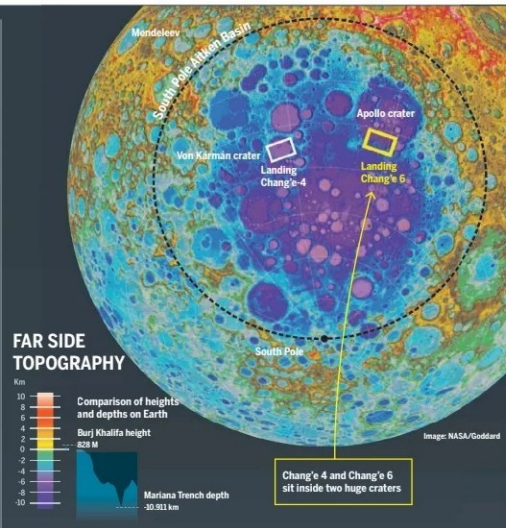
After the tasks were completed, the sample-loaded ascender lifted off from the lunar surface and reached lunar orbit to dock with the reentry capsule to transfer the samples.

In the final step, the reentry capsule flew back to Earth on Tuesday afternoon, delivering the precious samples for closer inspections.

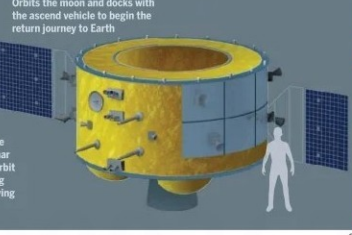
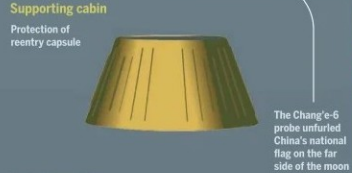
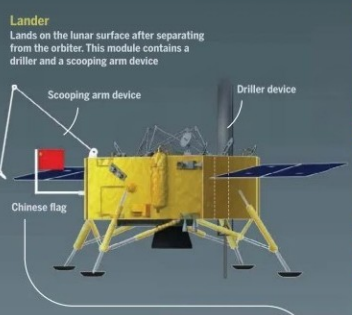


The Chang'e 6 mission includes new, international payloads from France, Sweden and Italy as well as a Pakistani cubesat.

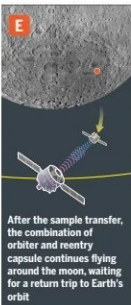
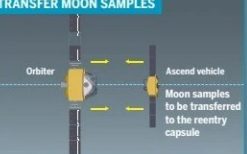
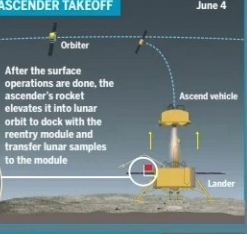
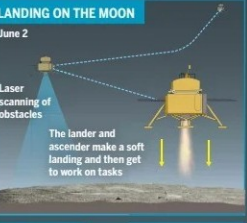
The Pakistani cubesat's missions are obtaining detailed images of the lunar surface, conducting intelligent on-orbit data processing of images, obtaining lunar magnetic field data, and verifying new space technologies.



## CHANG'E 6 INSIDE



## TASKS ON THE MOON



## BACK TO EARTH

