China’s Chang’e-6 Moon Sample Return and Future Plans.

China aims to send a pair of astronauts to the lunar surface before 2030*. [1]*

This will be facilitated by the China-led International Lunar Research Station (ILS) on the Moon to be operational by 2030 together with Roscosmos as a partner. [1]
A number of countries have signed up to participate in the ILS project. As of 2024 they include Azerbaijan, Belarus, Egypt, Nicaragua, Serbia, Pakistan, South Africa, Thailand, Venezuela, Kazakhstan. [2]

And they will do it

The statement above was emphasized by Chang’e-6’s flawless, completely successful un-crewed moon landing with sample collection and safe return to Earth on 25 June 2024.
This mission comprised all the ingredients of a crewed moon landing and unharmed return of astronauts to Earth, in particular it demonstrated all the technical and operational skills to do it.

Chang’e-6 Spacecraft

Chang’e Returner landing site in Mogolia

Chang'e 6 was the sixth robotic lunar exploration mission by the China National Space Administration (CNSA) and the second CNSA lunar sample-return mission. Like its predecessors in the Chinese Lunar Exploration Program, the spacecraft is named after the Chinese moon goddess Chang'e.

The mission began on 3 May 2024 when the spacecraft was launched on a Long March 5 rocket from Wenchang Space Launch Site on Hainan Island. Its lander and mini-rover touched down on the lunar far side on 1 June 2024. The lander's robotic scoop and drill took samples with a total mass of 1935.3 grams from the lunar surface; the *Ascender* module then lifted the collected samples into lunar orbit on 3 June 2024. The Ascender docked with the *Orbiter* module in lunar orbit on 6 June 2024 and transferred the samples to an atmospheric re-entry module which then returned to Earth. The mission's *Lander* and rover also conducted scientific experiments on the lunar surface.
The overall mission lasted about 53 days, ending on 25 June 2024 with the return capsule re-entering the atmosphere with the samples, landing by parachute in Inner Mongolia bringing back to Earth the first samples ever collected from the *far side of the Moon*.

Chang’e-6 Spacecraft
The Chang’e-6 spacecraft consists of four elements Chang'e 6 was built as a copy of and backup to Chang'e 5.

- *Lander* with attached mini-rover (located below the Ascender with landing legs) landed on the lunar surface after separating from the Orbiter, equipped with a drill and a scooping device. The Ascender is on the top of the Lander. It collected about 2 kg (4.4 lb) of samples from 2 meters (6.6

ft) below the surface and placed them in the attached ascent vehicle (Ascender) to be launched into lunar orbit. The time the samples had to be collected was limited to 14 hrs.

- *Ascender* (black box on top of the stack): The ascent vehicle then made a fully autonomous and robotic Lunar orbit rendezvous and docking with the Orbiter where the samples were robotically transferred with a push action into a sample-return capsule for their delivery to Earth.
- *Orbiter* (below the Lander adapter, with solar panels attached): After the samples were transported from the Ascender to the Orbiter, the Orbiter left lunar orbit and spent ~4.5 days flying back to Earth orbit and released the Returner (reentry capsule) just before arrival.
- *Returner* (return capsule on the bottom of the stack): The Returner performed a skip reentry to bounce off the atmosphere once before formal reentering.

The estimated launch mass was 8,200 kg (18,100 lb), the lander is projected to be 3,200 kg (7,100 lb) and the ascent vehicle is about 700 kg (1,500 lb). [3]

Mission Profile

The four vehicle combination was designed to be placed into a lunar orbit, where the Lander-Ascender combination separates and decent to land on the surface. Landed mass is approximately 3200 kg. Samples are collected and put in a container in the Ascender, which lifts off to rendezvous automatically with the Orbiter-Returner vehicle combination. It then deposits the sample container in the Orbiter-Returner combination, which brings the samples back to Earth, the Returner (return capsule) separating and reentering the Earth's atmosphere and landing with the samples on parachutes. [4]

The communications relay satellite, *Queqiao-2*, dedicated to the Chinese Lunar Exploration Program, was launched by a Long March-8 rocket from the Wenchang Space Launch Site in south China's Hainan Province on March 20, 2024, provided earth-moon communications services for Chang'e-6 from the far side of the Moon. Queqiao-2 entered its target elliptical orbit around the moon on April 2, 2024 and had completed in-orbit communication tests by April 12. [5]

Mission Control

Mission control- and flight operations for Chang'e-6 was provided by the Beijing Aerospace Flight Control Center (BACC), which includes also the operations responsibility for. the Shenzhou missions, and is located in a suburb northwest of Beijing under the administration of Haidian District on the campus of the "Aerospace City". BACC is subordinated to the *People's Liberation Army's Aerospace Force* controlling both military and civilian launches and satellites. [6]
Special appreciation shall be payed to the operations teams which performed this difficult task highly successfully.

International Cooperation

In addition to the Chinese instruments, the mission also carried international payloads, including a lunar radon detector from France and a negative ion analyzer from ESA. [7]
ESA's first lunar negative ion detector collected over three hours of data, exceeding mission requirements threefold and marking ESA's debut in lunar surface scientific data collection. This discovery of a novel plasma component on the lunar surface presents a fresh opportunity for space physics research and future human and robotic lunar exploration efforts. [8]

The Returner of the Chang'e-6 lunar probe was opened at a ceremony in Beijing on Wednesday afternoon, June 28, 2024.

During the ceremony at the China Academy of Space Technology under the China Aerospace Science and Technology Corporation, researchers opened the Returner and examined key technical indicators. Scientists involved with the ground application system will later carry out work related to sample storage, analysis and research as planned.

A reception ceremony for Chang'e-6 lunar samples is held at the National Astronomical Observatories under the Chinese Academy of Sciences (CAS) in Beijing, June 28, 2024.
A ceremony was held on Friday at the National Astronomical Observatories under CAS authority to receive the lunar samples collected by China's Chang'e-6 probe.
China's Chang'e-6 mission collected 1,935.3 grams of samples from the moon's far side, the China National Space Administration (CNSA) officially announced the same day. [9] (Photo/Xinhua)

The lunar samples, collected from the far side of the moon for the first time in human history, hold unique scientific significance as they will further enhance the understanding of lunar evolution, accelerate the pace of peaceful exploration and utilization of lunar resources, and serve as an important asset for all humanity, CNSA officials said.
CNSA officials also vowed to uphold the spirit of lunar exploration, characterized by "chasing dreams, daring to explore, collaborating to overcome challenges, and achieving win-win cooperation," and to ensure the proper management of the samples.
CNSA stated it will organize scientific research on the samples and share China's lunar exploration achievements with the international community.
Based on the lunar sample management rules released by CNSA and the experience in dealing with the applications for lunar samples collected by the Chang'e-5 mission, applications for the Chang'e-6 samples are expected to open to domestic research institutions and scientists in about six months, CNSA Ge Ping, deputy director of the CNSA's Lunar Exploration and Space - Engineering Center said. Regarding international applications, Ge Ping noted that China has always maintained a positive and open attitude and welcomes scientists from all countries to submit applications following relevant procedures. [9]
Planetologist Harald Hiesinger of the University of Munster, Germany, said that the Chinese collected the samples in geologically highly interesting terrain: The Apollo Basin belongs to one of the largest craters in the solar system, the huge South Pole-Aitken Basin.
This crater, more than 2000 km wide and around 10 km deep, was torn 4.3 billion years ago when a powerful celestial body impacted the lunar crust, which was just solidifying. “We hope that the samples from Chang'e-6 contain material from the underlying lunar mantle, which was exposed by the impact”. [10]

References

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