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News & Highlights

A Chinese Lander Explores the Far Side of the Moon

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Until 2019, astronauts and robotic spacecraft had only landed on the near side on the Moon—the side permanently facing the Earth. On 3 January 2019, China's Chang'e-4 became the first space mission to touch down on the Moon's far side (Fig. 1), most of which is not visible from Earth [1]. "Chang'e-4 is quite a remarkable accomplishment," said planetary geoscientist James Head of Brown University in Rhode Island, USA. It is the latest success for the ambitious Chinese space program, which later in 2019 will launch a spacecraft to retrieve samples from the lunar surface and in 2020 plans to send a probe to Mars.

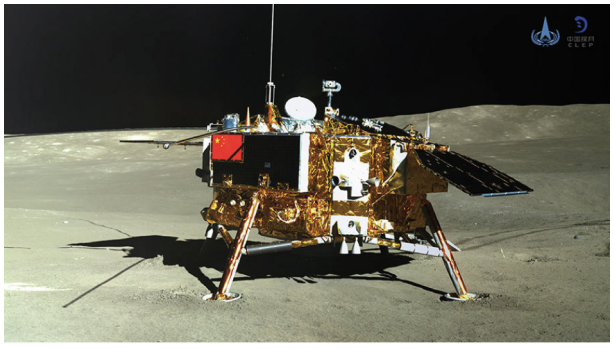
Chang'e-4 was originally intended as a spare in case its predecessor, Chang'e-3, failed [2]. But in 2013, Chang'e-3 became the first mission to land on the Moon since the Soviet Union's Luna 24 probe in 1976 [2]. After settling onto the Mare Imbrium, the basalt-paved remains of a mammoth impact crater, the lunar lander section of the spacecraft released Yutu, a 140 kg robotic rover. Although Yutu stalled prematurely, the mission collected a large amount of data, including results suggesting that the formation of the Moon's crust was more complicated than previously thought [3].

Chang'e-3's achievements allowed Chinese scientists to choose a new destination for Chang'e-4. They selected the Moon's far side, which researchers have long wanted to explore because it differs dramatically from the near side. The far side has a thicker crust, with more craters and few of the ancient lava flows, or marias, that scar the near side [4]. The far side also includes the South Pole–Aitken basin, which is up to 2500 km in diameter and 13 km deep, making it the largest impact crater on the Moon.

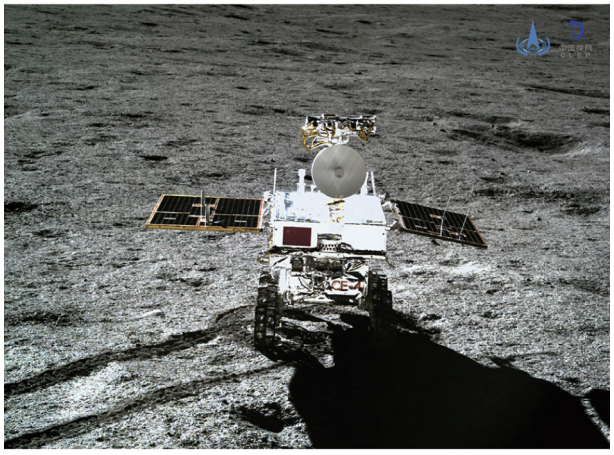
Studying geological features like these could help researchers answer fundamental questions about the Moon and early Solar System, said Head. For example, they might gain insights into the Moon's history, the reasons the two sides are distinct, and the duration of the debris bombardment that pummeled the early Solar System [5]. Until now, however, the far side of the Moon has received little scientific scrutiny. Unexplored areas of Earth used to be known as Terra incognita, but the far side of the Moon "is really Luna incognita," Head said.

Orbiting probes have flown over the far side, but "you really need to be on the surface to do detailed work" such as analyzing the composition of individual rocks, said planetary scientist Phil Stooke of Western University in Canada. Previous missions have not landed on the far side, Head said, because of the technical challenges. Communicating with Earth is difficult because the Moon obstructs the transmissions. To allow Chang'e-4 to stay in touch, in May 2018 China launched the Queqiao relay satellite that orbits about 65 000 km beyond the Moon, a location that enables it to relay signals from Earth to Chang'e-4, and vice versa [4]. "No one has ever done that before," said Stooke.

Chang'e-4 set down in the Von Kármán crater in the South Pole–Aitken basin. "It's exploring the most exciting place on the far



(a)



(b)

Fig. 1. (a) The Chang'e-4 lander on the Moon's far side and (b) the Yutu-2 rover, as photographed by the Yutu-2 rover and Chang'e-4 lander, respectively. Credit: China National Space Administration.

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side," said Head. Chang'e-4 includes a lunar lander and a rover, Yutu-2, and it carries a range of instruments and scientific experiments. For example, with its low-frequency radio spectrometer, the lander can detect radio waves from solar bursts. Yutu-2 began exploring the crater shortly after the landing, using its visible and near-infrared spectrometer to analyze the composition of the surface and lunar-penetrating radar to examine structures below ground. The impact that created the South Pole–Aitken basin may have forced some of the Moon's mantle—the layer beneath the crust—to the surface. Chang'e-4 could allow the mineral content of this material to be determined, providing clues about the Moon's interior composition [6].

Researchers with the mission released their first reports on the landing earlier in 2019 [7,8]. Their analysis of data from Yutu-2's visible and near-infrared spectrometer suggests that the crater contains olivine and low-calcium pyroxene, minerals that might have come from the mantle [8]. Scientists are eagerly awaiting publication of further results from the mission, said Stooke. Meanwhile, the Chinese space program is already moving ahead with more missions. Chang'e-5, scheduled for launch later in 2019, will land on the Moon's near side and bring samples back to Earth. If Chang'e-5 achieves its goals, Chang'e-6, which could lift off in 2020, will try to bring back material from the area around the Moon's South Pole, possibly from the far side. At a news conference earlier in 2019 in Beijing, officials from the China National Space Administration announced that Chang'e-7 and Chang'e-8 would continue to survey the Moon and perform experiments that could pave the way for construction of an international lunar base. In addition, China's space exploration will soon move beyond the Moon with next year's (2020) planned launch of a probe that will orbit and land on Mars [9].

References

[1] Castelvecchi D. China becomes first nation to land on the Moon's far side. Nature 2019;565(7738):146–7.

[2] Jones A. China launches first mission to land on the far side of the Moon [Internet]. Washington, DC: Smithsonian Enterprises; 2018 Dec 7 [cited 2019 May 20]. Available from: https://www.smithsonianmag.com/science-nature/china-launches-change-4-mission-land-far-side-moon-180970973/.

[3] Xiao L, Zhu P, Fang G, Xiao Z, Zou Y, Zhao J, et al. A young multilayered terrane of the northern Mare Imbrium revealed by Chang'e-3 mission. Science 2015;347(6227):1226–9.

[4] Normile D. China sets out for the far side of the Moon. Science 2018;362(6418):982–3.

[5] Fassett CI, Minton DA. Impact bombardment of the terrestrial planets and the early history of the Solar System. Nat Geosci 2013;6:520–4.

[6] Normile D. Chinese spacecraft successfully lands on moon's far side and sends pictures back home [Internet]. Washington, DC: American Association for the Advancement of Science; 2019 Jan 3 [cited 2019 May 20]. Available from: https://www.sciencemag.org/news/2019/01/chinese-spacraft-successfully-lands-moons-far-side-and-sends-pictures-back-home.

[7] Wu W, Li C, Zuo W, Zhang H, Liu J, Wen W, et al. Lunar farside to be explored by Chang'e-4. Nat Geosci 2019;12:222–3.

[8] Li C, Liu D, Liu B, Ren X, Liu J, He Z, et al. Chang'e-4 initial spectroscopic identification of lunar far-side mantle-derived materials. Nature 2019;569(7756):378–82.

[9] Gunia A. China plans to send a rover to probe Mars in 2020 [Internet]. New York: Time; 2019 Mar 4 [cited 2019 May 20]. Available from: http://time.com/5542658/china-mars-2020/.