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News & Highlights

Commercial Moon Landings Multiply

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Along with its familiar impact craters, the surface of the Moon sports numerous pale whorls and streaks known as lunar swirls [1]. Likened to the pattern produced when someone pours cream into a cup of black coffee [2], the swirls can extend for more than 50 km and have puzzled researchers for centuries [3]. Adding to their mystery, the features are associated with regions of magnetized rocks, an unusual attribute because the Moon lacks a magnetic field [3]. Researchers do not know how the swirls are related to the magnetic fields or how they formed. "They are enigmatic," said David Blewett, a planetary geologist at the Johns Hopkins Applied Physics Laboratory in Laurel, MD, USA.

In 2024, if all goes according to plan, scientists will get their first opportunity to study one of the swirls up close when the Lunar Vertex lander and rover touch down near the middle of the most famous of the features, Reiner Gamma (Fig. 1) [4]. But the Lunar Vertex mission, which Blewett heads, stands out not just for its scientific potential, but also because it will not get a lift from the US National Aeronautics and Space Administration (NASA) or some other government space agency. After flying to the Moon on a SpaceX (Hawthorne, CA, USA) Falcon 9 rocket, Lunar Vertex will be deposited on the surface by a lander built by the company Intuitive Machines of Houston, TX, USA [3].

Lunar Vertex is one of 70 missions now planned that private companies aim to send to the Moon in the next ten years [5]. Countries such as the United States and China have revved up their lunar exploration programs, too [6]. But by slashing the costs of spaceflight, these commercial ventures may give lunar research an additional boost. Now, scientists "have a more realistic chance of flying instruments to the Moon," said Ian Crawford, professor of planetary science and astrobiology at the University of London in the United Kingdom. The spaceflight companies still need to show that they can do what only countries with far more resources have done—land a craft on the Moon—and their efforts got off to a rocky start when the first commercial mission failed in April of 2023 [7]. However, scientists expect that the companies will overcome the initial setbacks and start delivering payloads to the lunar surface.

The Moon was a popular destination for US and Soviet spacecraft in the 1960s and early 1970s. However, no US mission has reached the surface since Apollo 17 in 1972. And the Soviet Union's final robotic lunar lander, Luna 24, returned to Earth in 1976 [8]. After that, "there was a long dry spell" in lunar exploration, said Blewett. The reasons for the pause were partly geopolitical—the space race between the Soviet Union and the United States was over—but they were also partly scientific, said Crawford. The Apollo missions brought back huge amounts of data and specimens

Fig. 1. Astronomers first observed the lunar swirl known as Reiner Gamma in the 1600 s but initially mistook it for a crater. Located in the northwest quadrant of the Moon's visible side, the light-colored feature stretches about 300 km; the oval central region where Lunar Vertex will land is about 30 km across. Credit: NASA (public domain).

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that needed to be analyzed. Moreover, in the planetary science community "there was the sense that the Moon had had its opportunity" and that other bodies in the Solar System deserved their turn, he said.

In the last decade or so, however, there has been "a big renaissance in lunar studies and exploration," said Crawford. Among countries, China has led the way, landing three Chang'e spacecrafts on the Moon since 2013 [8–10]. The United States plans to send astronauts to the Moon in 2025 [11]. And in 2023, India and Russia both launched robotic spacecraft to probe the lunar surface. However, while India's craft landed near the Moon's south pole, Russia's crashed [12,13].

Even with all this activity, national space programs can investigate only a few of the Moon's mysteries, creating opportunities for private companies. Lunar Vertex is one of the missions that will benefit from their delivery capabilities. Because no Moon landers have visited lunar swirls, researchers who study them must rely on telescope observations and data collected by lunar orbiters. "There is only so much you can do from orbital remote sensing," said Blewett. Lunar Vertex consists of two suites of instruments—one set on the lander and another set on the accompanying rover—that will gather ground-level data on Reiner Gamma. Among the lander's instruments are cameras and a magnetometer to measure the strength and direction of magnetic fields at the touchdown site [14]. The mission's 36 cm tall rover, meanwhile, carries its own magnetometer and a multispectral microscope to analyze the lunar soil, known as regolith [14]. Researchers hope the rover will be able to trundle at least 500 m, allowing it to explore the surface beyond the area disrupted by the lander's engines, said Blewett.

Scientists have proposed several hypotheses to explain the swirls that they will be able to test with data from Lunar Vertex. For instance, one hypothesis suggests that the features are lighter than the surrounding regolith because the magnetic fields associated with them deflect the solar wind, the stream of electrons and protons from the Sun that turns most of the Moon's surface dark [3,15].

NASA is not sending Lunar Vertex to the Moon. But it is paying the bills through the 2.6 billion US dollars Commercial Lunar Payload Services program (CLPS), which the agency launched in 2018 to spur investigation of the Moon and boost lunar exploration companies [16]. Lunar Vertex differs from a traditional NASA project in several ways. NASA spacecraft are custom-built for their missions. Lunar Vertex's scientific instruments are specialized, but the lander and rover are essentially off-the-shelf machines and "do not have to be designed from the footpads up," said Blewett. The same model of Nova-C lander (Fig. 2), built by Intuitive Machines, will deliver payloads on several other Moon missions [17]. In addition, Lunar Vertex will not have to undergo the same amount of prelaunch testing as a NASA spacecraft would, said Blewett. As a result, the chances of failure will be higher. However, for Lunar Vertex and other commercially delivered missions, "there is a greater acceptance of risk," he said.

A main payoff from this approach is that missions are cheaper. For Lunar Vertex, the cost for the instruments, rover, and other necessities for the mission, such as data storage, is 30 million US dollars, said Blewett. Overall, Intuitive Machines was awarded 78 million US dollars from CLPS to provide the lander and cover transportation on the SpaceX rocket [3]; that amount, however, also includes transportation and delivery for three other payloads from government space agencies on the same trip [18]. NASA has not landed any craft on the Moon in 50 years, so making an exact cost comparison is difficult. But the last NASA-designed mission to orbit the Moon, the Lunar Atmosphere and Dust Environment Explorer, which was launched in 2013, cost 280 million US dollars [19].

Fig. 2. The Nova-C lander from Intuitive Machines is 3 m tall, 2 m in diameter, and can tote 100 kg of cargo. The craft will carry the Lunar Vertex mission, along with three other government space agency and commercial payloads, to the Moon's surface in 2024. The same model of lander is also booked for two previous missions scheduled to touch down near the Moon's south pole in late 2023. Credit: NASA (CC BY 2.0).

If Lunar Vertex reaches the Moon in 2024 as scheduled, it may find other commercial craft already there. Another Intuitive Machines NOVA-C lander is set to transport a suite of NASA instruments to the Moon's south pole later in 2023 [20]. Astrobotic Technology of Pittsburgh, PA, USA, also has a scheduled landing in 2023, although technical problems with the rocket that will launch the spacecraft have led to delays [21]. Other 2024 arrivals include NASA's VIPER rover, also an Astrobotic Technology delivery, which will search for ice at the Moon's south pole [22].

So many spacecrafts are heading for the south pole of the Moon, including NASA's crewed Artemis II mission, that researchers have begun to worry about contamination of the lunar environment. The south pole is intriguing to scientists because many of its craters contain ice [23]. This ice may help researchers better understand the early history of the Earth and the Moon, and organic molecules it harbors could provide clues about how similar molecules arrived on Earth. But spacecraft exhaust could contaminate the ice [24]. An international agreement may be necessary to ensure the ice is not altered before researchers can study it, said Crawford.

Companies hoping to send craft to the Moon still have plenty to prove. For one thing, they must show that they can make money from lunar ventures [25]. So far, most of their clients are government space agencies, but they are starting to expand. The lander that carries Lunar Vertex will also carry several commercial payloads, Blewett noted.

The lunar landing companies must also demonstrate they have the right stuff to get a payload to the Moon's surface. Private companies regularly deliver satellites into orbit around the Earth, but sending a spacecraft to the lunar surface is much more difficult [7]. The first commercial craft to attempt the feat, the Hakuto-R Mission 1 lander from ispace of Tokyo, Japan, crashed in April of 2023 [26]. A software error led to an incorrect reading for the craft's altitude [26]. Despite this inauspicious start, Crawford thinks the companies will succeed. "They will learn," he said. "I think people will be surprised by the sheer number of missions that land on the Moon."

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