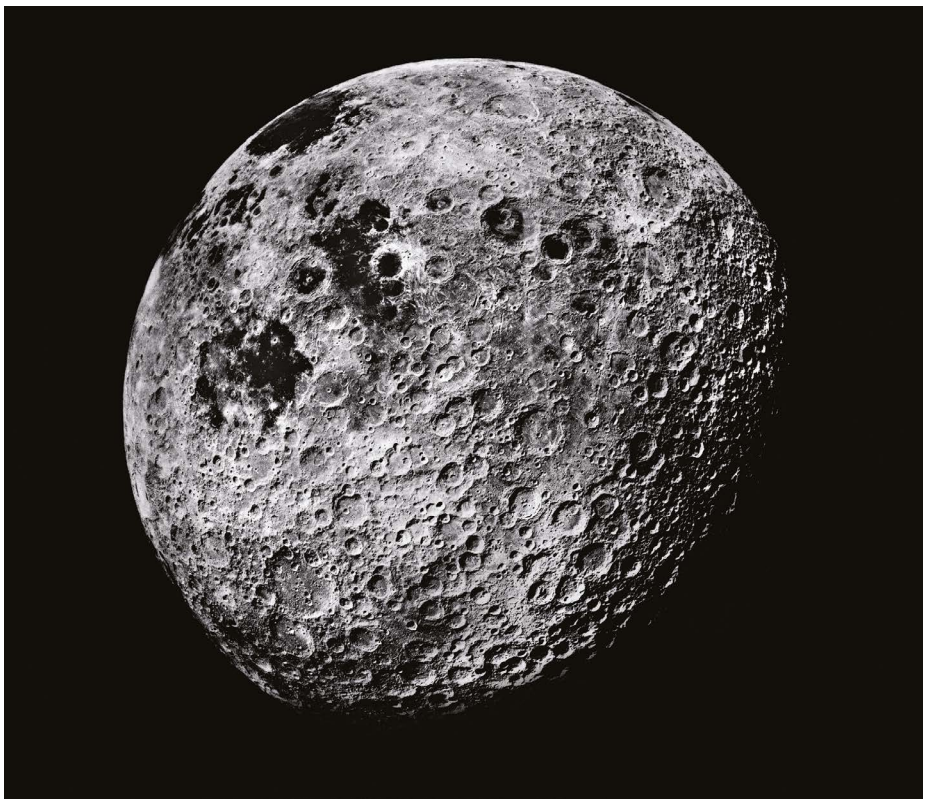

NASA/SPL

China is heading back to the Moon later this month.

CHINA SET TO RETRIEVE FIRST MOON ROCKS IN 40 YEARS

Chang'e-5 has just one lunar day to collect material from a previously unexplored region of the Moon.

By Smriti Mallapaty

Later this month, a Chinese spacecraft will travel to the Moon to scoop up lunar rocks for the first time in more than 40 years. The mission, named Chang'e-5, is the latest in a series of increasingly complex trips to the lunar surface led by the China National Space Administration (CNSA), following its first touchdown of a craft, Chang'e-4, on the Moon's far side last year.

"To take it to the next level and return samples from the Moon is a significant technological capability," says Carolyn van der Bogert, a planetary geologist at the University of Münster, Germany.

The craft is expected to take off on 24 November from the Wenchang Satellite Launch Center on Hainan Island. Its original launch, planned for 2017, was delayed because of an engine failure in China's Long March 5 launch rocket.

Chang'e-5's mission is to collect dust and debris from a previously unexplored region of the Moon's near side and return them to Earth. If the mission is successful, it will retrieve the first lunar material since the US and Soviet missions in the 1960s and 1970s (see 'Lunar landings'). Lunar scientists will be eager to study the new samples because of what they might learn about the Moon's evolution. The material could also help researchers more accurately date the surfaces of planets such as Mars and Mercury.

"The landing site was extremely wisely picked," says Harald Hiesinger, a geologist also at the University of Münster.

Grab and go

Chang'e-5 includes a lander, ascender, orbiter and returner. After the spacecraft enters the Moon's orbit, the lander-and-ascender pair will split off and descend close to Mons Rümker, a 1,300-metre-high volcanic complex in the northern region of Oceanus Procellarum — the vast, dark lava plain visible from Earth.

Once the craft has touched down, it will drill down as far as 2 metres into the ground and extend a robotic arm to scoop up about 2 kilograms of surface material. The material will be stored in the ascender for lift-off.

The descent and ascent will take place over one lunar day, which is equivalent to around 14 Earth days, to avoid the extreme overnight temperatures that could damage electronics, says Clive Neal, a geoscientist at the University of Notre Dame in Indiana.

The mission is technically challenging, and many things could go wrong, says Neal. The lander could crash-land or topple over, and the samples could escape from the canister along the way. "We all hope that it works," he says.

Once the ascender is back in lunar orbit, the samples will be transferred to the returner. The in-flight rendezvous will be complex and "a good rehearsal for future human exploration", says James Carpenter, a research coordinator for human and robotic exploration at the European Space Agency in Noordwijk, the Netherlands. Several countries are planning further lunar missions over the next decade (see page 186), and China plans to send people to the Moon from around 2030.

The Chang'e-5 spacecraft will then journey back to Earth, with the lander parachuting towards Siziwang Banner in Inner Mongolia, northern China, probably sometime in early December.

Most of the lunar samples will be stored at the Chinese Academy of Sciences National Astronomical Observatory of China in Beijing, says Li Chunlai, deputy chief designer for the Chang'e-5 mission. Some material will be stored at a separate site, safe from natural hazards, and some will be set aside for public display, says Li.

But it is not clear whether samples will leave the country. The CNSA supports international collaboration and giving researchers outside China access to the samples if they work with Chinese scientists, says Xiao Long, a planetary geologist at the China University of Geosciences in Wuhan, who was involved in selecting the landing site.

Hiesinger hopes that access to the samples will be similar to how researchers access rocks collected by the US Apollo missions — by submitting a proposal to NASA on how they plan to use them.

But Xiao points out that scientists at Chinese institutions cannot access Apollo samples because the US government restricts NASA from collaborating directly with China.

Evolutionary insights

The Chang'e-5 samples could fill an important gap in scientists' understanding of the Moon's volcanic activity. Rocks obtained by previous US and Soviet lunar missions suggest that activity on the Moon peaked 3.5 billion years ago, then faded away and stopped. But observations of the lunar surface have uncovered regions

LUNAR LANDINGS

China's Chang'e-5 mission is the first to collect lunar material since the Soviet and US missions in the 1960s and 1970s. It will touch down in the northern part of Oceanus Procellarum, a vast lava plain.

● US mission ● Soviet mission

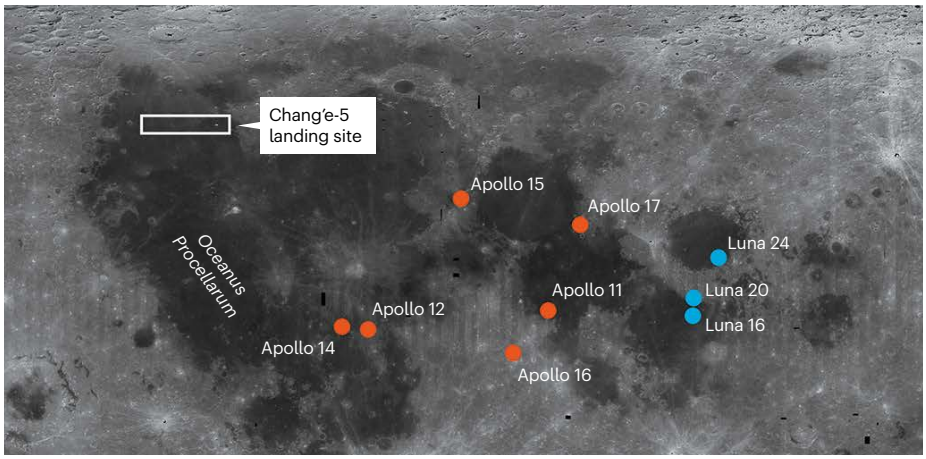

IMAGE: NASA

that could contain volcanic lava formed as recently as one billion or two billion years ago.

If Chang'e-5's samples confirm that the Moon was still active during this time, "we will rewrite the history of the Moon", says Xiao.

Studying the rocks' composition could also clarify what fuelled this thermal activity for so long.

The Moon is also an important reference for dating planets, based on the method of counting craters. The general rule is that older regions have more and larger craters, whereas younger regions have fewer and smaller ones. These relative ages are then given absolute dates using samples from the Moon. But no samples exist for the period between 850 million years and 3.2 billion years ago. Chang'e-5 could fill that gap. "The Moon is the only place where we have samples that we know exactly where they came from," says van der Bogert.

UAE ANNOUNCES FIRST ARAB MOON MISSION

The United Arab Emirates has already launched a Mars orbiter and is ramping up its space ambitions.

By Elizabeth Gibney

The United Arab Emirates (UAE) has announced plans to send a compact rover named Rashid to study the Moon in 2024. The revelation marks an intensification in the small nation's spacefaring ambitions. If Rashid is successful, the UAE Space Agency could become only the fourth to operate a craft on the Moon's surface, and the first in the Arab world.

The Mohammed Bin Rashid Space Centre (MBRSC) in Dubai says its in-house teams will develop, build and operate the 10-kilogram rover, which is named after the late Sheikh Rashid bin Saeed Al Maktoum, who ruled Dubai at the UAE's creation in 1971.

The team will hire an as-yet unannounced space agency or commercial partner to carry out the launch and landing, the riskiest part of the mission. If successful, Rashid would be one of several rovers made by private firms and space agencies that are set to populate the Moon by 2024 (see page 185).

Scientific study

For a country with just 14 years' experience in any kind of space exploration — and which this year launched its first interplanetary orbiter on a journey to Mars — building a rover presents a host of fresh challenges.

The relatively simple rover will have six scientific instruments, including four cameras. "They're not biting off more than they can chew at this stage," says Hannah Sargeant, a planetary scientist at the Open University in Milton Keynes, UK. "I think they're actually being quite smart about it."

Rashid will be just one-tenth of the mass of China's Chang'e-4, the only currently active lunar rover. The UAE craft will include an experiment to study the thermal properties of the Moon's surface, providing insights into the composition of the lunar landscape. Another experiment will study the make-up and particle size of lunar dust in microscopic detail, says Hamad Al Marzooqi, project manager for the lunar mission at the MBRSC.

Rashid's most exciting instrument is a Langmuir probe, says Sargeant. A first on the Moon, this will study the plasma of charged particles that hovers at the lunar surface, caused by the streaming solar wind. This environment electrically charges dust in a process that is little understood, she says.

Surface-based experiments to understand the charged environment are essential, because the conditions make lunar dust stick to surfaces, which could be dangerous for future crewed missions, she adds. "It's really sharp, tiny grains that get everywhere, that stick everywhere and can be hazardous to astronauts if they inhale a lot."

Rashid will land at an unexplored location at a latitude between 45 degrees north or south of the equator on the Moon's near side. This allows for easier communication with Earth than would be the case for a far-side probe, and should also mean a landing that is less rocky than one in the Moon's polar regions. The precise location, however, has yet to be selected from a shortlist of five.

The mission is scheduled to last at least one lunar day — around 14 Earth days — and Rashid could travel anywhere from a few hundred metres to several kilometres. The team is hoping the craft will also last through the equally long lunar night, when the temperature drops to around −173 °C. Previous rovers often carried a heat source. But overnight survival will mean developing new technology for a diminutive rover, says Adnan Al Rais, programme manager for the UAE's long-term initiative to settle humans on the red planet, known as Mars 2117, which also encompasses lunar exploration. He declined to reveal the Rashid mission's budget, but said that all scientific data would be openly available to the international community.

Addressing challenges

The Emirates Lunar Mission is the first of a series of missions that are intended as a platform for developing technologies, says Al Rais. The technologies will eventually support missions to the Martian surface, and address food, energy and water-security challenges back home, where natural resources can be similarly scarce. "It's challenging, but as you know we love challenges here in the UAE," says Sara Al Maeeni, an engineer on the Rashid's communication system.

Rashid's low weight also means it can fly on a commercial lander, which could reduce the mission's overall cost. Being small and light means "it's faster in development and easier to find a