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NASA

NASA astronaut Eugene Cernan led the Apollo 17 mission to the Moon in 1972.

PLANETARY SCIENCE

US scientists plot return to the Moon's surface

Lunar researchers seize on Trump administration's political interest in exploration.

BY ALEXANDRA WITZE

When Apollo astronaut Gene Cernan stepped off the Moon in December 1972, it marked the end of US researchers' access to the lunar surface. Since then, no US mission has touched down there to collect scientific data.

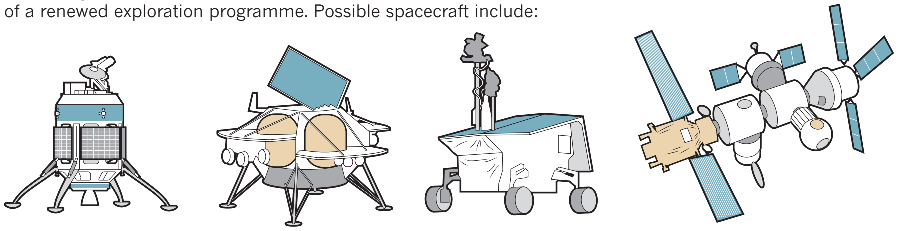
That could soon change. In December, US President Donald Trump ordered NASA to send astronauts back to the Moon. On 12 February, he proposed a 2019 budget that would allow the agency to begin planning a US$200-million lunar exploration programme. In the weeks since, NASA officials have started sketching out how that effort might unfold — from a series of small commercial landers, to larger NASA landers, to a multinational space station near the Moon that could serve as a base for robots and astronauts travelling to the lunar surface.

For US Moon researchers, Trump's plan is the first chance for an extended research programme since President Barack Obama cancelled exploration plans in 2010. "It's an exciting time to be a lunar scientist," says Ryan Watkins, a Moon expert at the Planetary Science Institute who works in St Louis, Missouri.

Congress has yet to approve either the president's budget request or his nominee to lead NASA, Representative James Bridenstine (Republican, Oklahoma). But for now, the agency's acting administrator is moving ahead ▶

BACK TO THE MOON

NASA may send landers to the lunar surface for the first time since the 1970s, as part of a renewed exploration programme. Possible spacecraft include:



MX-1 LANDER

Builder: Moon Express of Cape Canaveral, Florida

Destination: Anywhere on the lunar surface

Capabilities: Carry small payloads selected through a NASA competition

Time frame: As early as 2019

PEREGRINE LANDER

Builder: Astrobotic of Pittsburgh, Pennsylvania

Destination: Anywhere on the lunar surface

Capabilities: Carry small payloads selected through a NASA competition

Time frame: As early as 2019

LUNAR ROVER

Builder: NASA

Destination: Anywhere on the lunar surface

Capabilities: Study or collect rock samples from different geological formations

Time frame: Early 2020s

LUNAR ORBITAL PLATFORM-GATEWAY

Builder: International space agencies

Destination: Lunar orbit

Capabilities: Provide laboratory and storage space for samples, a refuelling point for surface operations and a communications relay

Time frame: Mid-2020s

SOURCE: NASA

▸ with the lunar push (see 'Back to the Moon').

Over the past decade, NASA has sent the Lunar Reconnaissance Orbiter to map the Moon; the Lunar Crater Observation and Sensing Satellite to crash land near the south pole in search of water; the Gravity Recovery and Interior Laboratory to plumb the Moon's gravity field; and the Lunar Atmosphere and Dust Environment Explorer (LADEE) to study its tenuous outer atmosphere.

These and other missions have opened new areas of research, says Dana Hurley, a planetary scientist at the Johns Hopkins University Applied Physics Laboratory in Laurel, Maryland. "Our understanding has evolved so much in the last decade," she says.

Take LADEE, which detected traces of water in the Moon's atmosphere that were probably carried there by meteorites. Researchers need more detailed data to better understand how water moves around on the lunar surface and into the atmosphere. "We didn't even know to ask those questions before," Hurley says.

She and other US scientists, in a collaboration known as the Lunar Exploration Analysis Group, have been studying how future missions might answer key science questions. Getting better dates for impact craters on the Moon, for instance, could help establish whether the Solar System experienced a cataclysmic meteorite bombardment 4 billion years ago.

"To take the next really big leaps in lunar science is going to take landing on the ground and getting at it with instruments in a way very similar to what we've done for Mars," says Barbara Cohen, a planetary scientist at NASA's Goddard Space Flight Center in Greenbelt, Maryland, who has developed methods for dating planetary samples on the surface of other worlds (B. A. Cohen *et al. Geostand. Geoanal. Res.* **38,** 421–439; 2014). "We have a lot of pent-up demand."

For the first time, NASA might use commercial landers to reach the lunar surface. Companies such as Moon Express of Cape Canaveral, Florida, and Astrobotic of Pittsburgh, Pennsylvania, have been developing small landers. Neither they nor their competitors were able to claim the $30-million Google Lunar XPRIZE, a private effort to put landers and rovers on the Moon by the end of this month. Still, many expect NASA to call in the coming months for proposals that rely on small commercial landers.

"This is the right place. This is the right time," NASA's Sarah Noble told a planetary-science advisory committee on 21 February. "We are really poised to take advantage of this next era of lunar exploration and the opportunities these commercial companies are going to open up."

The first lander missions would probably be short-lived trips to sites on the Moon's near side. But scientists could piggyback on those trips to study topics such as the plasma environment around the lunar poles, or to begin establishing a network of geophysical landers that would listen for moonquakes. By the mid- to late 2020s, NASA might be able to bring samples back to Earth via the space station orbiting the Moon.

Other nations will grab the lunar limelight much sooner. India is slated to launch its Chandrayaan-2 rover later this year to explore near the Moon's south pole. And China is planning to send its Chang'e-4 rover to the lunar far side — a first for any space agency — by the end of 2018.

NASA's challenge will be to keep its latest initiative from falling by the wayside, as did its last big lunar programme — which ran from 2004 to 2010. "I'm excited about the lunar exploration campaign, but concerned we're not making enough investments to get to the surface," says David Kring, a planetary scientist at the Lunar and Planetary Institute in Houston, Texas. He notes that Trump directed astronauts to the Moon; robotic landers do not achieve that goal, no matter how much data they collect. ■

POLICY

EU pesticide review could lead to ban

Major assessment concludes that neonicotinoids harm bees.

BY DECLAN BUTLER

In a long-awaited assessment, the European Union's food-safety agency has concluded that three controversial neonicotinoid insecticides pose a high risk to wild bees and honeybees. The findings by the European Food Safety Authority (EFSA) in Parma, Italy, increase the chances that the EU will soon move to ban all uses of the insecticides on outdoor crops.

In 2013, the EU prohibited use of the three chemicals on crops attractive to bees — such as sunflowers, oilseed rape and maize (corn) — after an EFSA assessment raised concern about the insecticides' effects. Since then, researchers have amassed more evidence of harm to bees, and the European Commission last year proposed banning all outdoor uses, while still allowing the pesticides in greenhouses. The latest EFSA assessment strengthens the scientific basis for the proposal, says Anca Păduraru, a European Commission spokesperson for public health and food safety. EU member states could vote on the issue as soon as 22 March.

Neonicotinoids (often abbreviated to neonics) are highly toxic to insects, causing paralysis and death by interfering with the central nervous system. Unlike pesticides that remain on plant surfaces, neonicotinoids are taken up throughout the plant — in the roots, stems, leaves, flowers, pollen and nectar.