News in focus

JOEL KOWSKY/NASA

NASA's Perseverance rover takes off for Mars aboard an Atlas V rocket from the Cape Canaveral Air Force Station in Florida.

NASA LAUNCHES THE MOST AMBITIOUS MARS ROVER EVER BUILT

Perseverance will stow away rocks for eventual delivery to Earth, and will listen for Martian sounds for the first time.

By Alexandra Witze

The biggest, most complex rover ever sent to Mars is now on its way. NASA's Perseverance rover launched successfully on 30 July, the third of three Mars missions to take off in the space of just ten days. It will be the first mission ever to attempt to collect rock samples for return to Earth; it will also search for signs of ancient alien life, launch the first helicopter on the red planet and use microphones to capture Mars's sounds for the first time.

The rover blasted into the skies above Cape Canaveral, Florida, aboard an Atlas V rocket at 7.50 a.m. local time. The launch follows the United Arab Emirates' Mars Hope orbiter, which took off on 20 July, and China's Tianwen-1 rover, which launched three days after that. All three capitalized on a favourable alignment between the orbits of Earth and Mars for a fuel-efficient journey.

Now, Perseverance will cruise through space for nearly seven months, aiming to land in Mars's Jezero Crater on 18 February 2021. If it reaches the surface safely, the US$2.7-billion, plutonium-powered, 1,025-kilogram rover will spend at least one Mars year — nearly two Earth years — exploring a landscape where an ancient river flowed into a lake that might have hosted Martian life.

As well as searching the river bed and lake shore for signs of fossilized life, Perseverance will test whether astronauts could produce oxygen from the red planet's atmosphere. But most importantly, it will fill tubes with Martian rock and soil that another spacecraft might one day fly back to Earth — in what would be the first sample return from Mars (see page 16).

"Perseverance is going to do so much for us," says Kennda Lynch, an astrobiologist at the Lunar and Planetary Institute in Houston, Texas.

The machine is a beefed-up version of the Curiosity rover, which gripped the world when it landed on Mars 8 years ago in a nail-biting 7-minute manoeuvre. After a journey of roughly 500 million kilometres, Perseverance will hit the Martian atmosphere travelling at around 19,500 kilometres per hour. It will deploy a parachute and then a 'sky crane' system — similar to that used by Curiosity — that will fire retrorockets to slow it down as it approaches the planet's surface. Unlike Curiosity, the spacecraft has an autopiloting system to detect obstacles such as big rocks, and guide it to a safe location.

Once Perseverance lands, engineers will spend around 90 days remotely checking all of its systems to make sure they're in working order. The rover probably won't begin rolling in earnest until May, when it will strike out on its six wheels to explore Jezero Crater, which lies about 3,750 kilometres from Curiosity's landing site.

Jezero means 'lake' in several Slavic languages. More than 3.8 billion years ago, a river flowed into the 45-kilometre-wide crater, and lake waters filled it[1]. Images suggest that along the crater's rim, carbonate minerals settled out and hardened into rock[2]. That's exciting because on Earth, ancient carbonate rocks hold some of the oldest known evidence of life, including fossilized bacterial mats known as stromatolites[3].

If Martian life ever existed, Jezero's carbonates are a good place to look for it. "We've not explored an environment like this before," says Tanja Bosak, a geobiologist at the Massachusetts Institute of Technology in Cambridge who is working on the mission. Evidence of life could come in the form of actual fossils, or in chemical or geological signatures of organisms that once lived in the rocks.

Tools of the trade

The rover is loaded with instruments that make it a true field geologist — and truly international. They include a pair of zoomable cameras that can spot a fly from the other side of a sports field; a Spanish-built weather station; a Norwegian-built radar to scan layers of soil and rock beneath the planet's surface; and an advanced version of a laser instrument carried on Curiosity, which will probe rocks to study their chemical make-up. "Who doesn't love a camera with a laser that zaps rocks?" says John Grunsfeld, a former NASA astronaut who led the development of Perseverance when he ran the agency's science office from 2012 to 2016.

Perseverance is also pioneering because it carries two microphones, which will not only reveal the winds and other sounds of Mars for the first time, but will also be able to listen for engineering problems in the motors or wheels, Grunsfeld says. And it has a 1.8-kilogram helicopter named Ingenuity, which it can deploy to scout ahead for places where the rover could roll. If the mission is successful, Ingenuity will be the first craft to make a controlled flight on another planet.

There and back again

But the workhorse of Perseverance is its robotic arm, which can stretch to scrutinize rocks up close, and then drill out samples and store them in tubes in the rover's belly. The mission will stash these samples until a future spacecraft can retrieve them and bring them back to Earth. NASA and the European Space Agency plan to bring those rocks back to Earth by 2031 so that scientists can study them in sophisticated laboratories — although only a small part of the funding has yet been committed.

"Returning samples will be the first time we will have done a round trip to Mars," Grunsfeld says. "That's important because it's a metaphor for human space flight. Most astronauts who go to Mars are going to want to come back."

As a step towards that long-term exploration, the rover will use one of its instruments to attempt to produce oxygen from Mars's carbon dioxide atmosphere. Future human astronauts might be able to do the same, to make oxygen to breathe or produce rocket fuel to get home.

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The space missions that snatch pieces of other worlds

NASA is about to grab its first taste of Mars. On 30 July, its Perseverance rover launched to the red planet — the first step towards fulfilling a long-standing dream of planetary scientists. If all goes to plan, Perseverance will arrive in February 2021 and drive around, collecting samples of rock that, one day, other spacecraft will pick up and fly back to Earth. The rocks will become the first samples ever returned from Mars (see page 15).

They will join a priceless collection of cosmic material brought back from other planetary bodies, including the Moon and an asteroid. These samples have reshaped scientific study of the Solar System.

Without planetary missions, the only way scientists can directly study rocks from other worlds is to analyse meteorites that have fallen to Earth, but such events are rare, says Queenie Hoi Shan Chan, a planetary scientist at Royal Holloway University of London in Egham, UK.

So space agencies go to a lot of trouble to collect fragments of the Moon, Mars and other worlds. In well-equipped laboratories, researchers looking to understand these samples can apply tools and techniques that aren't available on a small spacecraft, Chan says.

The first and largest collection of samples comes from the Moon. Between 1969 and 1972, a dozen astronauts in NASA's Apollo programme brought back 382 kilograms of lunar rocks (see 'Sampling the Solar System'). Studies of those samples have rewritten scientific understanding of the Solar System.

"When Apollo 11 landed on the Moon, many considered that our small moon had formed cold," says Donald Brownlee, an astronomer at the University of Washington in Seattle. "This turned out to be spectacularly wrong." Studies of the rocks showed instead that the Moon was hot at its birth, more than 4.5 billion years ago, and covered with an ocean of molten rock.

Three Soviet Luna missions, all involving robots, also brought back small amounts of Moon dust between 1970 and 1976. And China plans to retrieve some lunar samples with its upcoming Chang'e-5 mission, which could launch by the end of this year.

The Japan Aerospace Exploration Agency (JAXA) is the only space agency so far to have brought back material from an asteroid. In 2010, the Hayabusa spacecraft returned from the potato-shaped asteroid Itokawa with more than 1,500 precious grains. Studies of the material confirmed, among other things, that the most common type of meteorite that falls to Earth, called an ordinary chondrite, comes from silicate-rich asteroids such as Itokawa. Two other asteroid samples