COSMOS

THE SCIENCE OF EVERYTHING

Issue 91 **Winter 2021**

TIME TRAVEL

EARTH'S EPIC HISTORY AND THE FUTURE OF LIFE

New Ancestor?
DNA detectives on the hunt

Tetris and Telepathic Mice
Mind meld made real

High Revolution
Gaia telescope's galactic gaze

Ri Aus

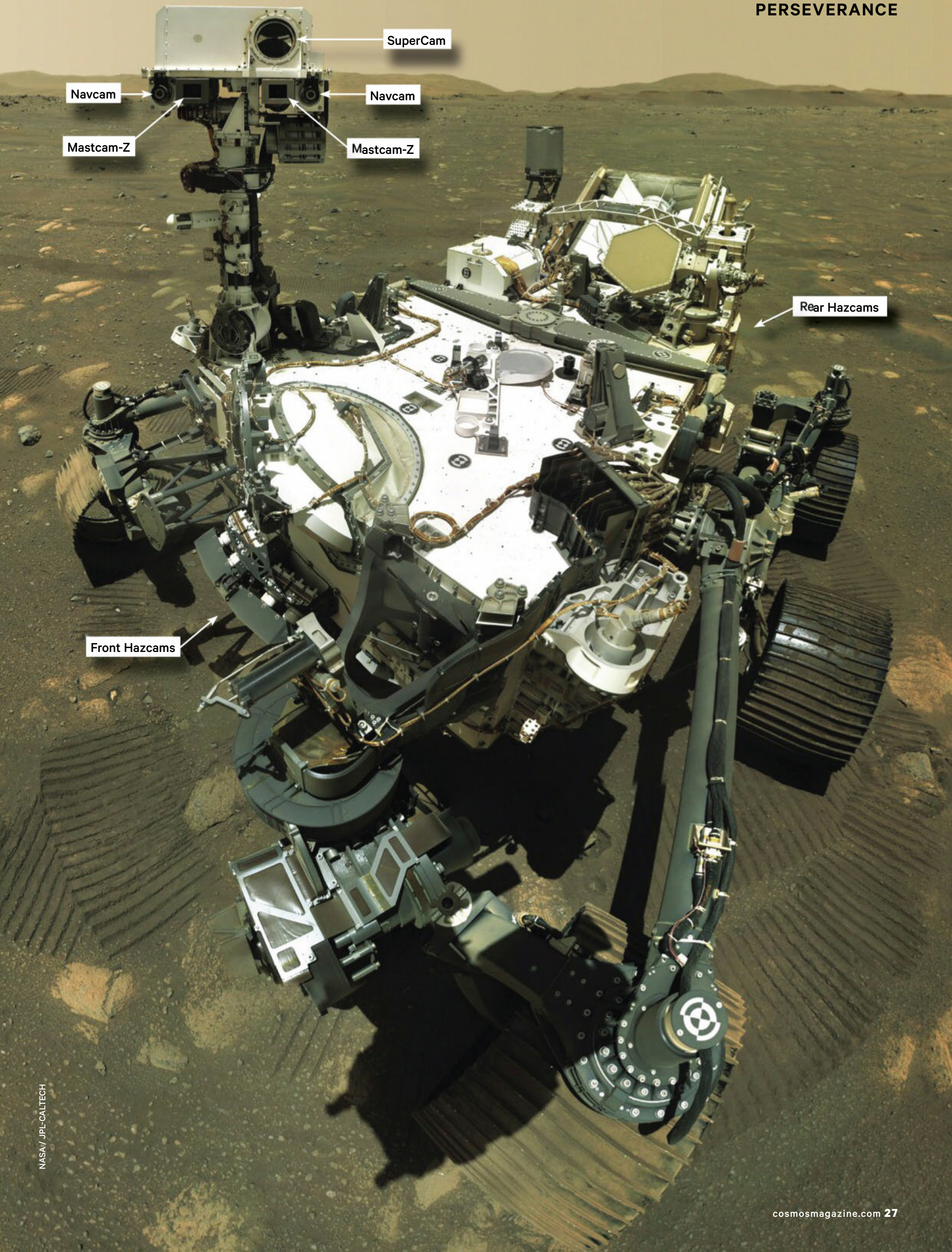
9 771832 522008

AU $15.00 NZ $16.00

Just a little PERSEVERANCE

Much of what NASA's achieving through the Mars 2020 mission – including the historic flights of tiny helicopter Ingenuity – will likely inform future explorations. As Perseverance continues to beam news and views back from Mars, TORY SHEPHERD reports on what's at stake, and the Australians who are part of the Mars 2020 team.

Master and apprentice, Perseverance took this April 6 selfie with Ingenuity after deploying the tiny aircraft. This image itself speaks of the mission's technological wonder: it's 62 individual frames stitched together, captured with a camera called WATSON (Wide Angle Topographic Sensor for Operations and eNgineering) located at the end of the rover's robotic arm, which ends up out of the picture when the mosaic is assembled.



NASA / JPL-CALTECH

It was a display of… well, ingenuity. A tiny, 1.8kg helicopter called Ingenuity hitched a ride to Mars on the Perseverance rover. On April 21, it flew – the first powered and controlled flight on another planet.

In a sense, NASA was just showing off when Ingenuity spun its rotors against the backdrop of the Red Planet, rose three metres into the air and hovered, then took some photographs, before dropping back down on the Martian landscape.

Twice more – on 22 April and again on 25 April – Ingenuity flew, the final time flying about 50 metres downrange from its take-off position at an altitude of about 5 m, for a total flight time of close to a minute and a half.

One could dismiss these flights as mere displays – but they're displays of what's to come.

One day, there might be swarms of these tiny choppers on Mars, scouring the landscape for information – including the possible proof of extra-terrestrial life. That's what Queensland University of Technology's Dr David Flannery pictures. Flannery is a planetary scientist, and a long-term planner and co-investigator in NASA's 2020 Mars mission.

His PhD was awarded for research into the evidence for life in ancient rocks in Western Australia (WA). After that, he went to work for NASA's Jet Propulsion Laboratory (JPL) as part of the Mars 2020 team. There, he started working on PIXL – the Planetary Instrument for X-ray Lithochemistry, an instrument to search for ancient microbial life that was proposed by another Australian at JPL, Dr Abigail Allwood.

"I translate the expertise I have in ancient rocks," Flannery says.

"For my bread-and-butter research I look at really old rocks, because I'm interested in the early evolution of our planet and life on our planet.

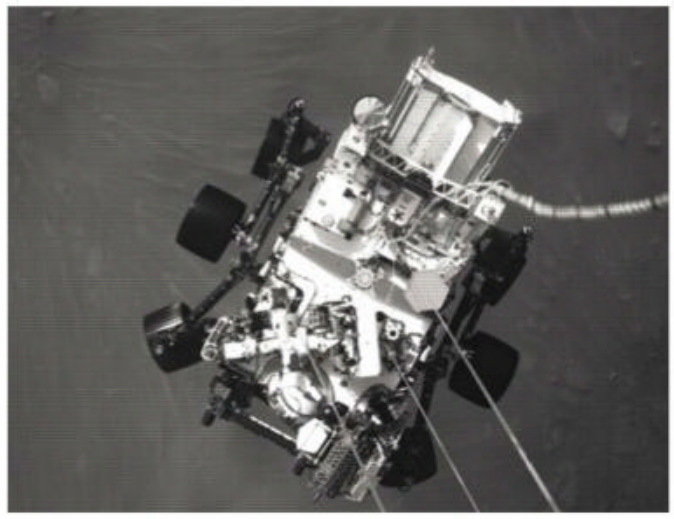
"At the moment we're looking at similar rocks on Mars that are about the same age.

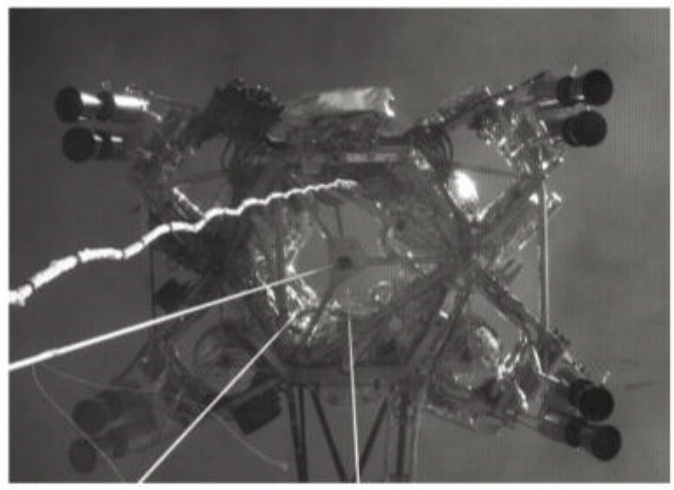
"We're for the first time officially looking for evidence of past life in the rock record of Mars. On Earth we find various lines of evidence for microbial ecosystems that were present and we'll be looking for the same sorts of evidence on Mars."

As a long-term planner, Flannery's part of the team that will decide where to send Perseverance. Now Ingenuity can help them make those decisions. It will act as a scout.

"In the future we might consider sending more, maybe dozens," he says.

"I think that's the way Mars will go in the future. A helicopter demonstration like this allows us to test some of the technology. Autonomous flight, communications – a swarm would need to communicate with each other and operate without a human in the loop.





FEBRUARY 18: LANDING AND WHAT DOES MARS SOUND LIKE?

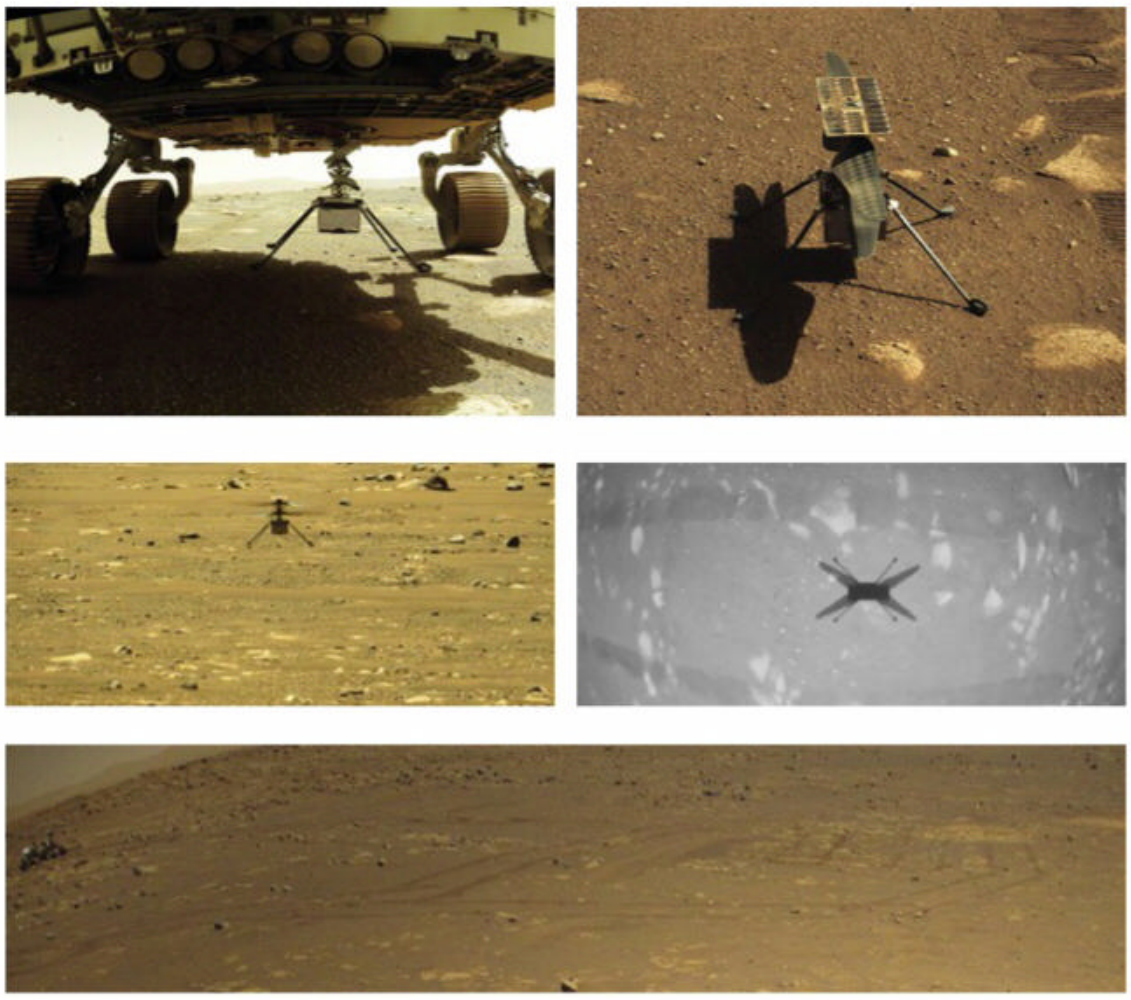
Stunning video shot on Perseverance's landing day shows the rover plummeting, parachuting and rocketing toward the surface of Mars.

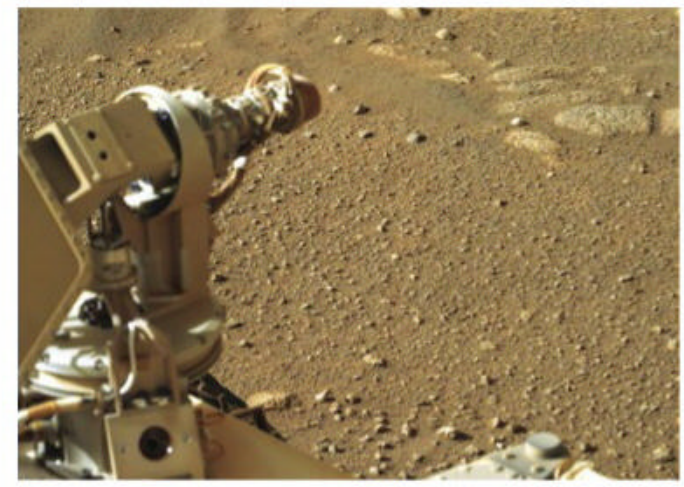
"For those who wonder how you land on Mars – or why it is so difficult, or how cool it would be to do so – you need look no further," says acting NASA Administrator Steve Jurczyk. "Perseverance is just getting started, and already has provided some of the most iconic visuals in space exploration history."

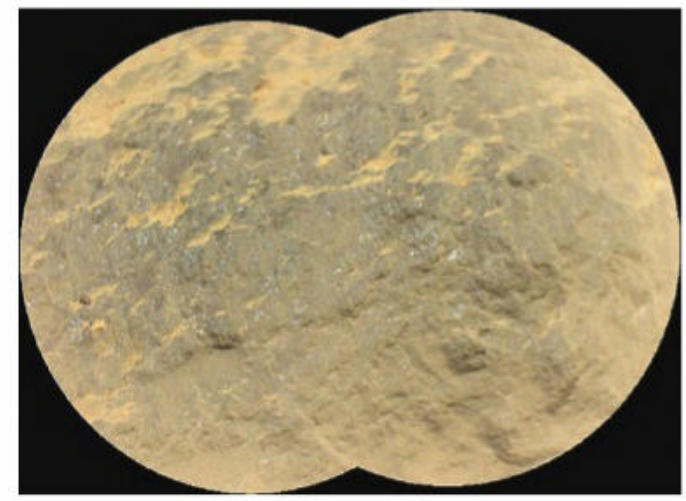
After touchdown, a microphone on the rover doubles down on cool by picking up a remarkable first, recorded on 20 February: audio recordings from the Jezero Crater on Mars.

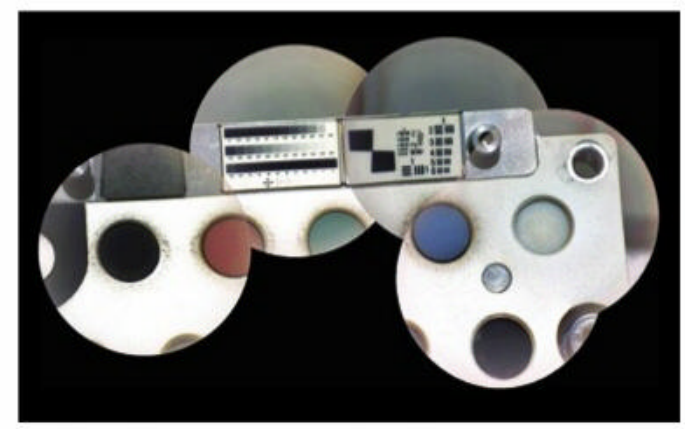
About 10 seconds into the one-minute recording, a Martian breeze is audible for a few seconds, as are mechanical sounds of the rover operating on the Red Planet's surface.

BELOW: BILL INGALAS / NASA / JPL-CALTECH. ALL OTHERS: NASA / JPL-CALTECH



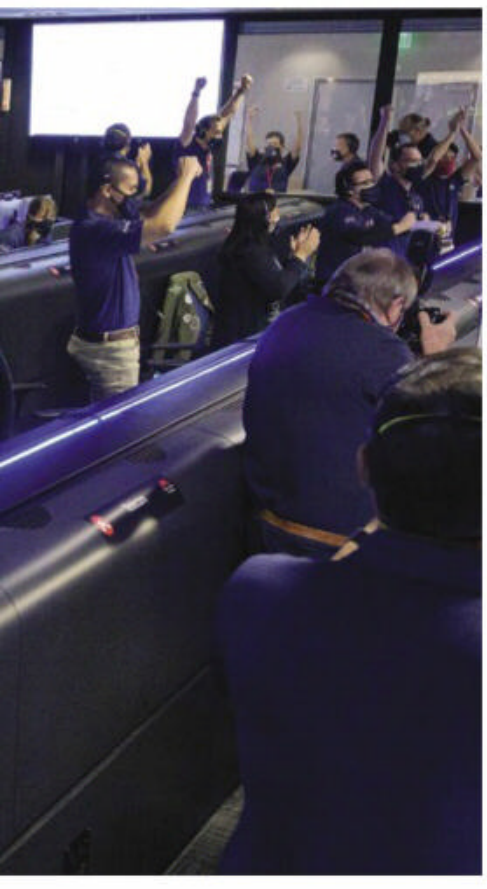






NASA / JPL-CALTECH

After being dropped out of Perseverance's belly (top left), Ingenuity sat alone (top right) through various systems tests for several days, before taking its first flight (above middle pair) on 19 April. On Ingenuity's third flight, on 25 April, it snapped the Mars rover (above, at far left) about 85m away and the rover's landing site (at far right).



"In the future we could use helicopters like this to scout for us, in new areas that we can't see from orbit. We can't drive the rover everywhere. It's absolutely incredible, and it's incredible that engineers from JPL could put this together in a short period of time, to integrate it with the mission, deploy it and fly it."

Allwood and Flannery both studied fossil stromatolites in 3.45-billion-year-old rocks in WA's Pilbara. Allwood proved the structures were stromatolites and therefore evidence of microbial activity. Then she went to JPL and started developing PIXL, which she told ABC News, sits on the rover "like a little six-legged insect".

PIXL can look at rock features as small as a grain of salt and detect chemical elements, searching for signs of ancient life.

The NASA Mars 2020 deputy program scientist is another Australian – Dr Adrian Brown. He told the COSPAR 2021 conference on space that finding stromatolites on Mars would "change the mission straight away". "We would immediately be answering the question of how prevalent life is on other planets. It would be 'all pens down'."

The role of Ingenuity and future rotorcraft will be to help the rover find candidate sites, and it's hoped eventually they will be able to grab samples and carry them back to the rover, and to PIXL for analysis.

For about seven months, the little chopper was carried 470 million kilometres to Mars in the belly of the Perseverance rover. When Perseverance landed, it released the tiny helicopter in the Jezero Crater, which scientists think was once a flooded river delta. It's a 45-km-wide basin that is a possible

MARCH 10: SCIENCE UNDERWAY AS SUPERCAM LASER-ZAPS MÁAZ

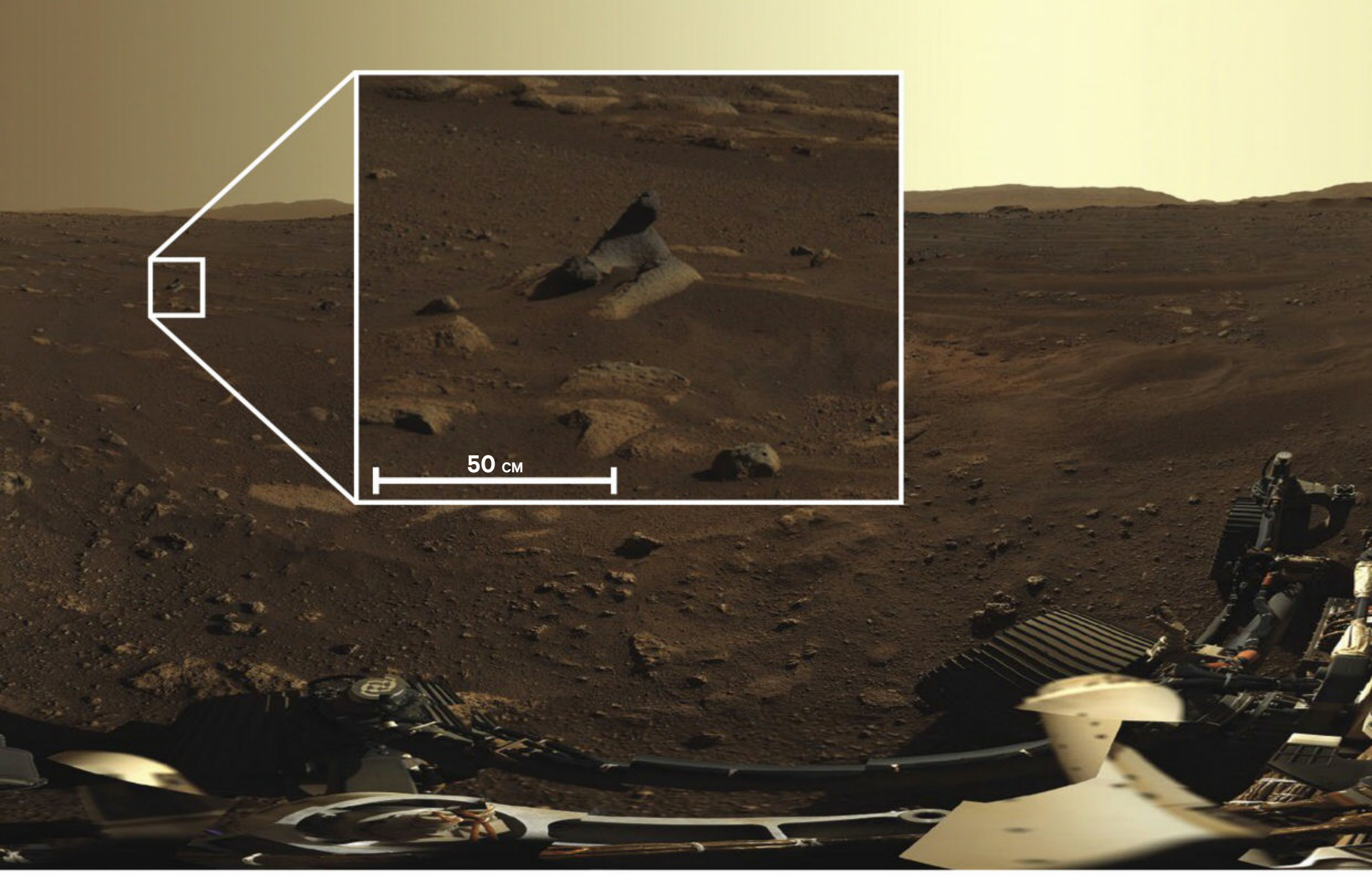
The first readings from Perseverance's SuperCam instrument arrived on Earth at the French Space Agency (Centre National d'Etudes Spatiales, CNES) operations centre in Toulouse.

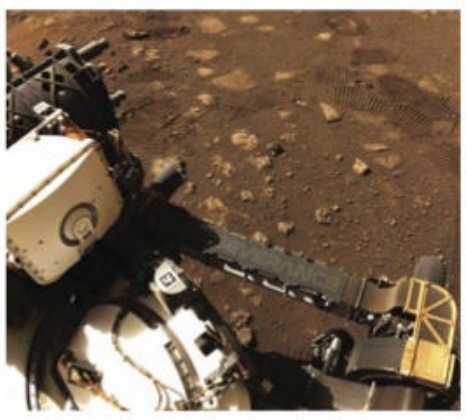
The data includes the first audio of "laser zaps" on another planet: a rock target (above, middle) named "Máaz" (Mars in the Navajo language).

"The sounds acquired are remarkable quality," says Naomi Murdoch, a research scientist and lecturer at France's Institut Supérieur de L'aéronautique Et De L'espace (ISAE-SUPAERO). "It's incredible to think that we're going to do science with the first sounds ever recorded on the surface of Mars!"

SuperCam is collaborative project of the Los Alamos National Laboratory (LANL) in New Mexico, US, and a consortium of French research laboratories under the auspices of CNES.

And Máaz? The Perseverance team has a list of 50 names to use – for starters – that it developed with the US's Navajo Nation.





APRIL 6: HERE'S THE MARTIAN WEATHER REPORT

NASA releases the first weather from the Jezero Crater, pieced together from data from the Mars Environmental Dynamics Analyser (MEDA) system aboard Perseverance. MEDA engineers had first received initial data from MEDA a day after the rover touched down.

The data showed it was just below -20°C on the surface when the system started recording, and that the temperature dropped to -25.6°C within 30 minutes.

Over the next year, MEDA will provide valuable information on a range of matters that might inform the design of the planned mission to return to Mars to collect samples. MEDA measurements will also provide information to engineers considering future human missions to Mars.

site for Martian microbial life. The crater, which is about the same age as those WA rocks, was chosen from 60 potential sites for stromatolites, and it won in part thanks to what NASA calls its "bathtub ring" – around the rim of the crater are deposits of carbonates, which in turn could indicate the presence of stromatolites.

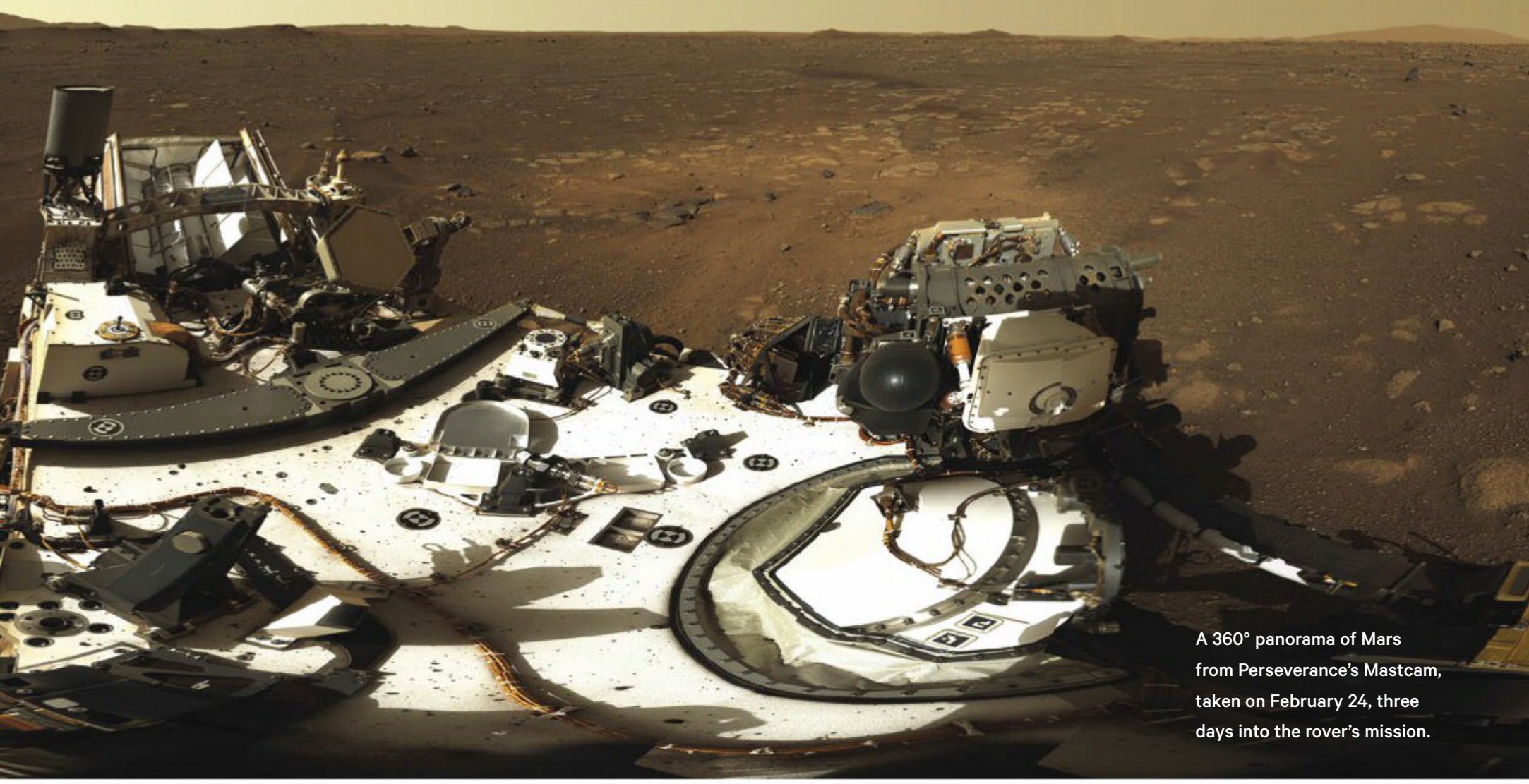
What Ingenuity had to achieve to become a useful part of the search, was flight in a very different atmosphere. Compared to Mars, Earth's atmosphere is like custard: easy to push against. While Martian gravity is less than half that on Earth, it's harder to fly in because the atmosphere is 1% of Earth's, so there's less to push against.

And Ingenuity had to react to its environment on its own because it takes 16 minutes for instructions to come from our pale blue dot – imagine a helicopter waiting that long to be told how to react. It also uses solar power to charge its batteries and to keep it warm enough to deal with the cold Martian nights, which can get down to -90°C.

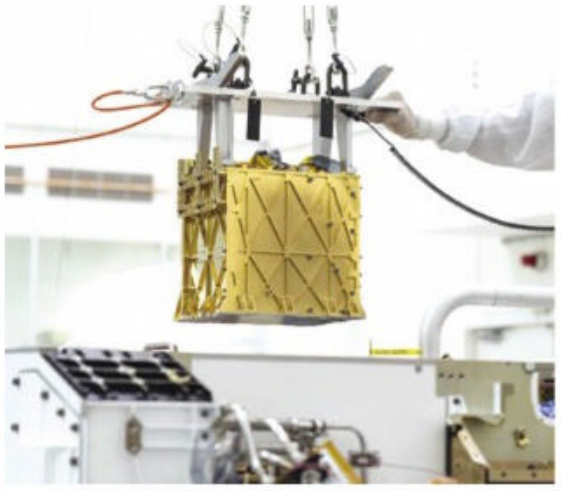
Ingenuity had to be super light, with miniaturised flying technology. It had to have super-fast rotors (NASA says its "specially made carbon-fibre blades [are] arranged into two rotors that spin in opposite directions at around 2400 rpm – many times faster than a passenger helicopter on Earth").

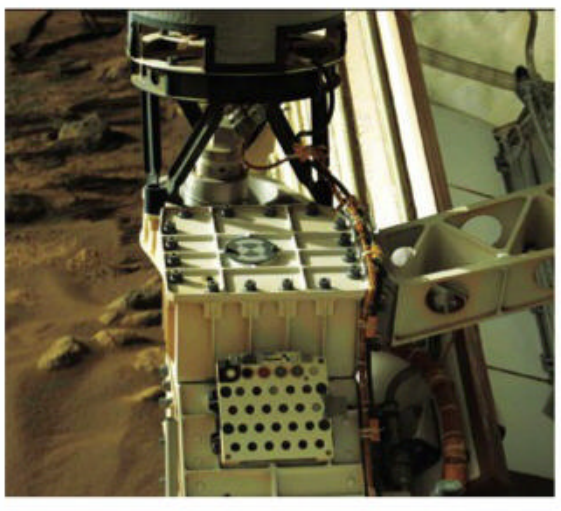
It succeeded. While doing so, it carried a swatch of the same fabric that covered the wings of the Wright Flyer, the aircraft built and flown by Orville

NASA / JPL-CALTECH



A 360° panorama of Mars from Perseverance's Mastcam, taken on February 24, three days into the rover's mission.





NASA / JPL-CALTECH

Find regular Ingenuity and Perseverance updates at **www.cosmos magazine.com**

APRIL 20: LET'S MAKE SOME OXYGEN

The list of firsts for Perseverance grew when NASA announced that an instrument on the rover had converted some of Mars' thin, carbon-dioxide-rich atmosphere into oxygen. The toaster-sized experimental instrument is called the Mars Oxygen In-Situ Resource Utilization Experiment (MOXIE).

While the tech demonstration is in early days, it could lead to science fiction becoming science fact: isolating and storing oxygen on Mars to help power rockets that could lift astronauts off the planet's surface. Such devices also might one day provide breathable air for astronauts themselves.

Not that anyone could live for long on the amount of gas MOXIE produced in its first one-hour test: about 5.4 grams, according to the instrument's principal investigator, Michael Hecht of Massachusetts Institute of Technology's Haystack Observatory. "That's about enough to keep a typical active astronaut alive for 10 minutes," he says.

and Wilbur Wright to make the first powered, controlled flight on Earth in 1903.

Former US astronaut and unabashed Mars enthusiast Buzz Aldrin, who himself made space history during the 1969 Apollo 11 Moon landing, said "today we watched history occur in real time".

He tweeted his congratulations to NASA and the Perseverance team, saying: "This historic flight of the Mars Helicopter truly is one small step that'll produce another giant leap for future Mars exploration!"

That giant leap might not be very far away. NASA has already given Ingenuity a new mission. After its first four flights – each one more adventurous than the last – NASA's Thomas Zurbuchen said the little chopper remained "in excellent health", and that so far its work had been a "resounding success".

Once it fulfilled its job of proving that flight is possible, NASA decided it was time for the next step. Operators will start testing out Ingenuity's limits, its precision manoeuvring abilities and aerial observation capabilities. As Perseverance starts moving towards promising rocky outcrops, Ingenuity's job is to scout the rover's targets and potential routes, taking images of inaccessible features, and to continue the search for life outside Earth.

TORY SHEPHERD is an Adelaide-based journalist. Her last feature, about Australia's race into space, appeared in Issue 90.