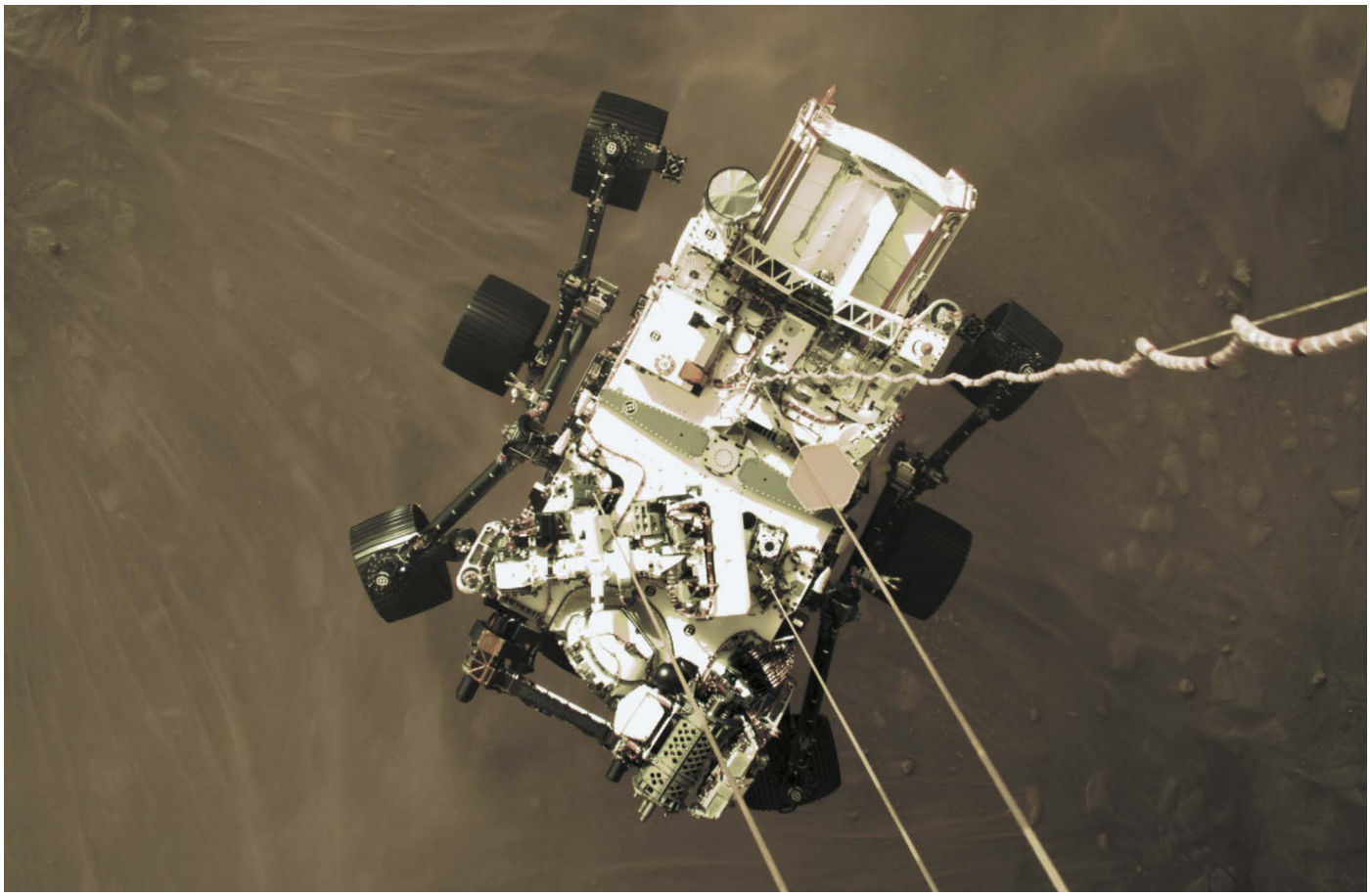
News in focus



NASA/JPL-CALTECH

Perseverance is lowered onto Mars's dusty surface by a rocket-powered 'sky crane'.

TOUCH DOWN! NASA'S MARS LANDING SPARKS NEW ERA OF EXPLORATION

Having pulled off its nail-biting landing, the Perseverance rover will now look for signs of life and collect rocks to return to Earth for the first time.

By Alexandra Witze

NASA's Perseverance rover touched down safely in Jezero Crater on Mars on 18 February, kicking off a new era of exploration on the red planet in which rocks will be collected and returned to Earth for the first time.

Encased in a protective heat shield, Perseverance whizzed through the thin Martian atmosphere and then deployed a parachute to slow itself down. In a final landing manoeuvre, a 'sky crane' holding the rover fired its rockets to gently lower the six-wheeled, car-sized Perseverance to the surface. A full-colour video assembled from multiple cameras shows the drama of its final minutes of descent.

The rover touched down at 3.55 p.m. US Eastern time, after a nearly seven-month journey from Earth. The first images from the surface show a dusty landscape studded with rocks, including several sitting near one of its wheels that have a porous texture, possibly because of gases that bubbled out of a volcanic flow. Perseverance is now sitting on the smooth, dark floor of Jezero Crater, about 2 kilometres southeast of what was once a river delta, when the crater was filled with water more than 3.5 billion years ago.

The landing went as smoothly as engineers had hoped. "I almost feel like we're in a dream," says Jennifer Trosper, the mission's deputy project manager at the Jet Propulsion Laboratory (JPL) in Pasadena, California. In the first few days after landing, all systems on board the rover checked out as healthy. It switched on its high-gain antenna to communicate more efficiently with Earth, and raised a tall mast laden with cameras to survey its surroundings.

Initial images taken by the navigation cameras and stitched together into a 360° panorama show the high cliffs of the river delta in the distance. A microphone on board Perseverance also captured the sound of a wind gust on the surface, the first audio ever recorded on Mars. In the coming days, the rover will straighten up its wheels and do a short test drive, then unfold and test its robotic arm laden with scientific instruments.

The mission's goal is to roll around Jezero Crater — an area of Mars that was once much warmer and wetter, and perhaps even liveable (see 'A watery past') — and collect rock samples that will give NASA its best chance yet at answering the age-old question of whether life ever existed on Mars. Ultimately, the rover will leave those samples at certain spots on the Martian ground where future spacecraft can retrieve them — making Perseverance the first step in a multidecadal effort to bring Mars rocks to Earth.

NASA/JPL-CALTECH

NASA's Perseverance rover starts to explore Mars.

Exploring the terrain

Perseverance's arrival was even more of a nail-biter than other Mars landings, because the rover touched down in a geologically challenging spot. Jezero is full of steep cliffs, large boulders and treacherous sand dunes that the spacecraft needed to miss. Engineers at the JPL, which was where Perseverance was built, developed hazard-avoidance techniques to ensure a safe touchdown. Most notably, as Perseverance descended towards Jezero, it used a downwards-pointing camera to quickly photograph the landscape and compare the terrain with a set of maps stored on board. The spacecraft then steered itself away from hazards, coming to rest on a flat spot in one of the few safe areas. "Everything looks great," says Trosper.

The last rover to reach Mars was NASA's Curiosity, in 2012. It has been exploring an ancient lake bed in Gale Crater, where it has discovered evidence for a once-habitable environment (although it found no actual evidence of past life on Mars).

Jezero's ancient, fractured landscape is the oldest terrain ever explored on the red planet. "This region is a very old part of Mars," says Vivian Sun, a planetary geologist at the JPL and a member of the Perseverance science team. "That's important because the oldest periods of time are when we think Mars was most habitable."

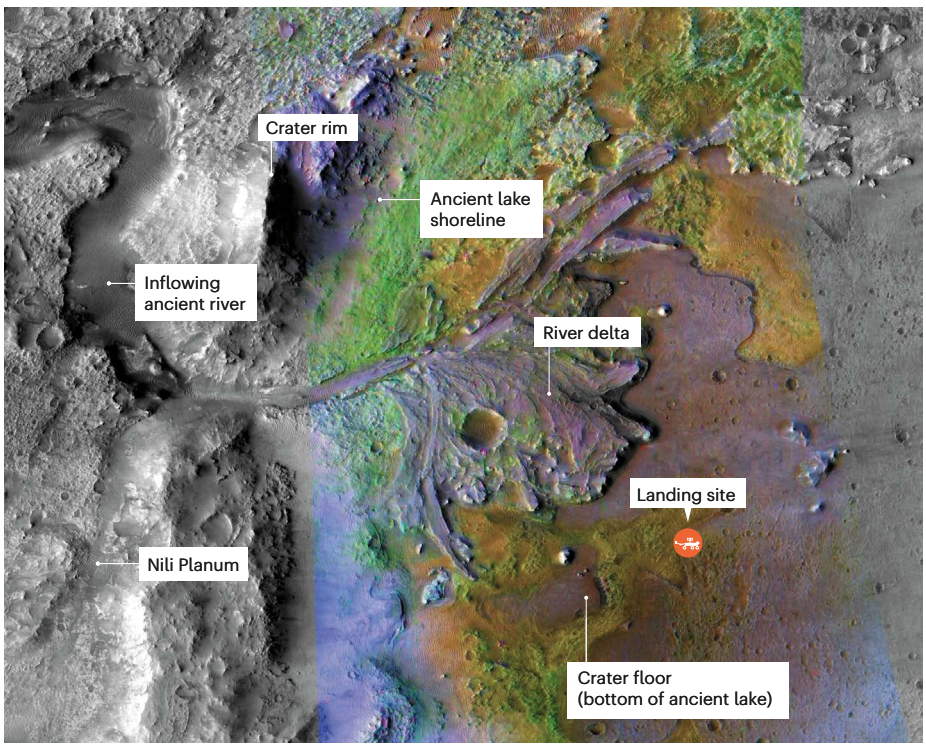
Perseverance carries two microphones — the first ever sent to the planet — to listen to Martian sounds, such as wind and the crunch of rover wheels rolling across the surface. In 2018, NASA landed another craft, the InSight probe, some 3,500 kilometres away. It has a seismometer that listens for 'marsquakes' shaking the ground. InSight scientists think there is a small chance that the probe 'heard' Perseverance land on Mars, when two large parts of the rover's landing system hit the surface. It would be the first seismic detection of a known impact on another planet and could reveal more information about the Martian interior, because waves such as these can help to map geological features below the surface. As *Nature* went to press, InSight scientists had not revealed whether they had detected Perseverance's landing.

Meanwhile, NASA's Mars Reconnaissance Orbiter captured a dramatic view of the landing from orbit, a snapshot of Perseverance falling towards the surface with its enormous parachute slowing its descent. It also photographed the debris of the landing — the discarded parachute, heat shield and other components — spread out across Jezero.

In the coming weeks, Perseverance will roll away from its landing site and lower a tiny, 1.8-kilogram helicopter from its belly onto the

A WATERY PAST

Billions of years ago, a river flowed into Jezero Crater from the west, spilling into what was then a large lake and creating a delta. Perseverance landed 2 kilometres southeast of the ancient delta.



SOURCE: NASA/JPL-CALTECH/MSSS/JHU-APL/BROWN UNIV.

surface. The helicopter, named Ingenuity, will test the first powered flight on another world. "It will truly be a Wright Brothers moment, but on another planet," says MiMi Aung, the helicopter's project manager at the JPL.

During Perseverance's first 3 months on the surface, team scientists and engineers are working on Mars time, in which a day is nearly 40 minutes longer than an Earth day. That means they often work through the night, their lives pushed into a sort of permanent jet lag. Working on Mars time, however, allows the team to be more efficient in planning daily operations, after checking in with the rover at the start of each Martian day.

Perseverance aims to travel quickly and efficiently, journeying at least 15 kilometres across Jezero and up onto its rim in one Mars year (which is nearly two years on Earth) — the time NASA allotted for the initial mission. The rover carries 43 tubes for collecting Martian rock and dirt; the goal for that initial mission is to fill and lay down 15–20 of them on the crater rim for future spacecraft to pick up.

Rock collector

If the rover is still working well after its first Mars year, it will head out from the crater rim onto the surrounding plains, called Nili Planum. This part of its journey will explore the most ancient terrain yet, including enormous blocks of jumbled-up rock that were blasted from deep inside Mars when another huge asteroid hit, nearly four billion years ago. These rocks could come not just from the Martian crust, but from a deeper layer of Mars known as the mantle — which scientists have never been able to look at directly before. "They're just sitting there, perhaps for more than three billion years, waiting for us to look at them," says Briony Horgan, a planetary geologist at Purdue University in West Lafayette, Indiana, and a member of the rover's science team.

Perseverance will drill and collect samples on Nili Planum until it runs out of tubes. The European Space Agency and NASA are working on plans for two missions needed to retrieve the samples. Launching no earlier than 2026, they would send a rover to retrieve the sample tubes laid down by Perseverance, as well as an orbiter to loop around Mars. The rover would put the tubes on a rocket and launch them into Mars orbit, where the orbiter would grab them and fly them back to Earth no earlier than 2031.

Perseverance, which launched in July 2020, cost US$2.4 billion to build and launch and another $300 million to land and operate, at least during its first year on Mars. It is the third mission to reach the red planet this month — following spacecraft from the United Arab Emirates and China, which are both now in orbit.

The Chinese mission, Tianwen-1, will try to land its own rover on the surface as early as May.

BETH ZAIKEN/CENTRE FOR PALAEOGENETICS

DNA from multiple mammoth species is illuminating a complex evolutionary picture.

MAMMOTH GENOMES SHATTER RECORD FOR OLDEST ANCIENT DNA

Permafrost-preserved teeth, up to 1.65 million years old, identify a new kind of mammoth in Siberia.

By Ewen Callaway

The million-year-old genome is here. Mammoth teeth preserved in eastern Siberian permafrost have produced the oldest ancient DNA on record, pushing the technology close to — but perhaps not past — its limits.

Genomic DNA extracted from a trio of tooth specimens excavated in the 1970s has identified a new kind of mammoth that gave rise to a later North American species. The findings were published in *Nature* on 17 February[1].

"I love the paper. I've been waiting for that paper for, what, eight years now," says Ludovic Orlando, an ancient-DNA specialist at the Centre for Anthropobiology and Genomics of Toulouse in France, who co-led a 2013 effort that sequenced the previous oldest ancient DNA — a genome from a 560,000–780,000-year-old horse leg bone[2]. "I'm pleased to lose this record, because it was a heavy one," he says.

Researchers had suspected that ancient DNA could survive beyond one million years, if the right sample could be found. Once an organism dies, its chromosomes shatter into pieces that get shorter over time. Eventually, the DNA strands become so small that — even if they can be extracted — they lose their information content.

Orlando's team found that fragments as short as 25 DNA letters in their horse bone, from the Canadian Yukon Territory, could still be interpreted. They estimated that million-year-old remains preserved in the constant cold of permafrost — which slows DNA fragmentation — should also contain fragments of that length. "My only doubt: does such a sample exist?" Orlando says.

Love Dalén, an evolutionary geneticist at the Swedish Museum of Natural History (SMNH) in Stockholm, had been dallying with the idea of sequencing very old mammoth remains since he first encountered a collection of them, in 2007. The samples his team sequenced, one from an early woolly mammoth (*Mammuthus primigenius*) and two assigned to a precursor known as steppe mammoths (*Mammuthus trogontherii*), had been excavated by the Russian palaeontologist Andrei Sher.

Dalén hoped that DNA from the samples could capture the evolution of woolly mammoths and other species in action, but he was sceptical because of previous bad experiences with much younger remains found in permafrost. "It's not like everything found in the