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Space exploration

Martian invasion

Landers, rovers and even a helicopter are descending on Mars this month, where they will search for signs of water and past life, says **Leah Crane**

MARS is a popular spot this month, with the United Arab Emirates's Hope orbiter, the Chinese Tianwen-1 probe and NASA's Perseverance rover all arriving at the Red Planet in quick succession.

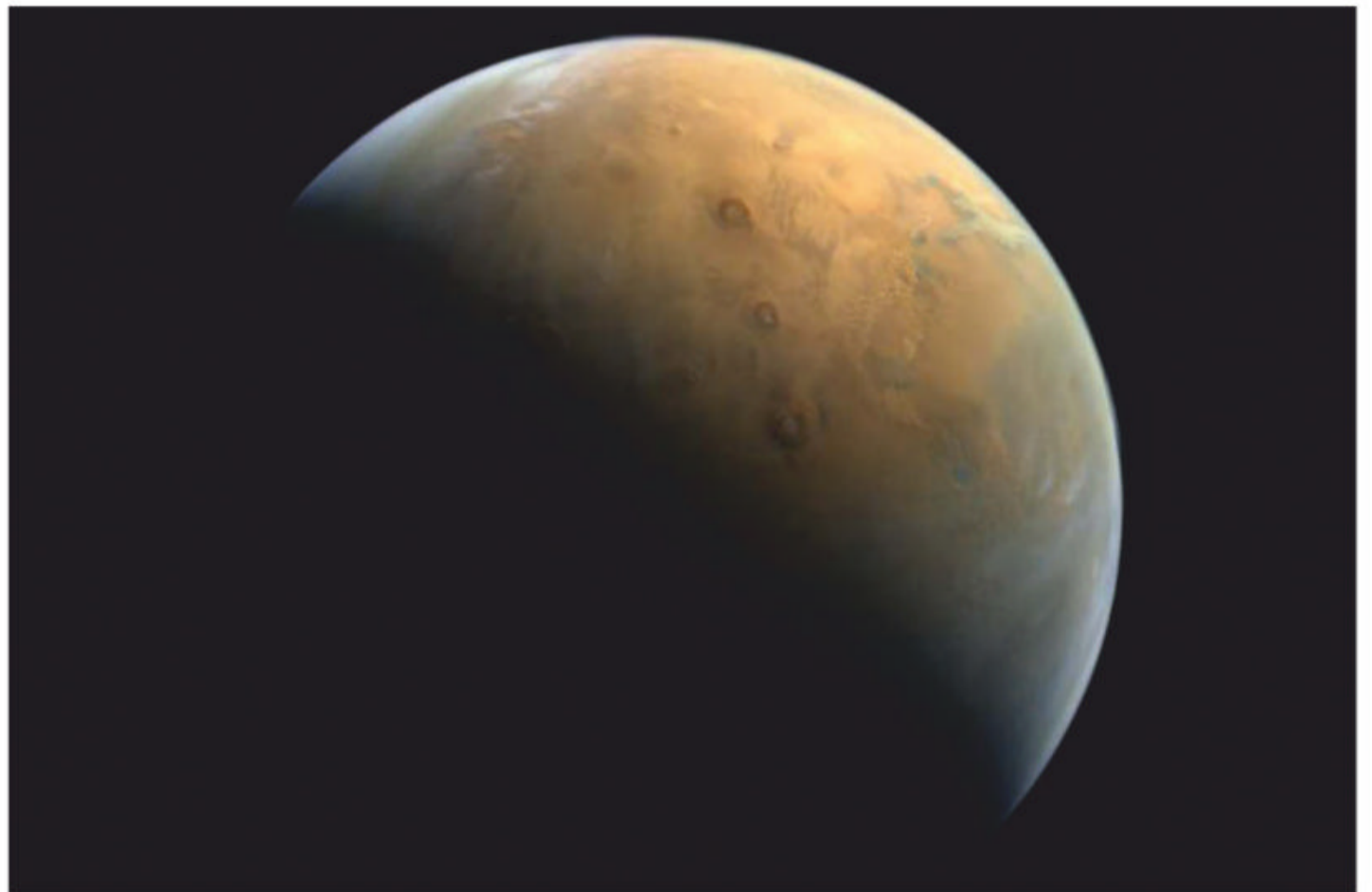
Hope and Tianwen-1 both entered Martian orbit last week (the first image of Mars beamed back from Hope is pictured right), while Perseverance, which launched on 30 July 2020, is due to touch down on 18 February. It is the largest vehicle ever to try to land on Mars, weighing in at just over 1 tonne. The rover is also carrying the first helicopter to visit another planet, a small drone called Ingenuity (see "First helicopter on another planet could glow in the dark", right).

Such a landing is difficult: about 60 per cent of the missions that have tried to set down on the surface have failed. Perseverance will follow a similar landing sequence to the Curiosity rover, which arrived successfully in 2012,

"Perseverance is the first leg of the first-ever round trip to another planet"

with a heat shield and parachute slowing it down from about 20,000 kilometres per hour to less than 4 kilometres per hour before a "sky crane" – a disposable craft that deploys thrusters to hover above the ground – lowers the vehicle gently to the surface.

Perseverance will land in Jezero crater, thought to be a dry lake bed, but we don't know the exact spot. "Once you hit Mars's atmosphere, the wind buffets you around and makes it harder to predict," says Briony Horgan at Purdue University in Indiana, part of the Perseverance team. Because of that and the rugged landscape, Jezero was thought to be too risky



UAE SPACE AGENCY/UP/SHUTTERSTOCK

to land in, but Perseverance has a navigation system that will take pictures as it nears the surface and autonomously pick a safe-looking landing spot.

Part of Perseverance's scientific goal is to look for evidence of past life on the Martian surface. However, even with its sophisticated instruments, it is unlikely that



AP/SHUTTERSTOCK

the rover will be able to confirm signs of life with certainty.

"The hope is we'll find very strong evidence – layers of organic material layered in with microbial mat textures on an ancient shoreline, something like that," says Horgan. "But we still need to check and make sure that some weird non-biological thing didn't cause this, and to do that, we really need to bring samples back to Earth and look at them in the lab."

That is why the other part of the mission is to grab samples of dust and rocks, carefully package them in 43 test tubes and leave them behind on the surface of Mars. Another mission that is planned for 2026 will then pick them up and bring them back to Earth.

"If it sounds complicated, it is. If it sounds extreme, it most

China's Tianwen-1 probe on its way to Mars. It will stay in orbit until May

certainly is," said Lori Glaze, NASA's director of planetary science, in a press conference. But it will be worth it, she said. "We expect samples of Mars to provide new knowledge for decades to come as we study them with state-of-the-art laboratory tools we couldn't possibly carry to Mars right now."

Scientists still study the rocks that the Apollo missions brought back from the moon between 1969 and 1972, and these new Mars samples could provide a similar way to conduct in-depth studies of the Martian surface from laboratories on Earth.

Bringing the samples back also has another benefit: it may act as a sort of dress rehearsal for crewed missions to Mars, which will presumably mean bringing people back from the Red Planet after sending them there.

"Perseverance is the first leg of the first-ever round trip to another planet," said Wanda Peters

The UAE's Hope orbiter took this image showing three volcanoes in a line on the surface of Mars

60%

The proportion of Martian landings that end in failure

20,000

Speed of Perseverance in kilometres per hour as it reaches the Red Planet

90

Number of Mars days Tianwen-1 rover will roam the surface

at NASA's Science Mission Directorate during a briefing. If the landing goes smoothly, that round trip will be well on its way.

But Perseverance won't be alone on the Martian surface: aside from the Curiosity rover, which is still trundling around Gale crater, the Tianwen-1 mission is also getting ready to drop off a rover.

China's craft entered Mars orbit on 10 February, just one day after the UAE's Hope probe. This is China's second interplanetary mission, but its first without international partners. Tianwen-1 has three parts: an orbiter, a lander and a rover.

Multiple goals

"While Perseverance is a very focused mission – it's one rover that has a very clear goal of looking for life and collecting samples – I think Tianwen-1 is an attempt to see how much they

can do at once," says Horgan.

Now that Tianwen-1 is safely circling Mars, the next step is to start the preparations for sending the mission's lander to the surface. Scientists have selected a site for this in Utopia Planitia, the same region where NASA's Viking 2 lander touched down in 1976. Tianwen-1 will take pictures of the area from orbit to make sure conditions are safe. Unlike Jezero crater, Utopia Planitia is relatively flat.

If everything looks clear, the lander will be released. It will hurtle towards the Martian surface, slowing down with the help of a cone-shaped heat shield and a parachute before a set of rockets brings it softly to rest on the ground. This is expected to happen around May, giving the mission team plenty of time to assess the landing site.

Finally, assuming all goes to plan, the lander will release a solar-powered rover to explore the dusty surface for about 90 Martian days. This vehicle is equipped with cameras, ground-penetrating radar, a magnetic field detector, a weather station and an instrument to measure the chemical composition of the dust and rocks. The orbiter also carries its own scientific instruments to investigate Mars from orbit.

Together, all of these tools will aid in the search for pockets of liquid water and ice on Mars, as well as laying the groundwork for future missions. "It's pretty similar in a lot of ways to the Viking missions, which were also NASA's first landers on Mars," says Horgan.

Like NASA's subsequent Mars missions, China's future plans for the Red Planet are more complex, including an attempt to bring samples back to Earth for analysis in the late 2020s, similar to the US follow-up to Perseverance. ■

Mars reconnaissance

First helicopter on another planet could glow in the dark

Jonathan O'Callaghan

NASA is about to fly a helicopter on Mars, and it turns out that its rotors could glow in the dark.

A few weeks after the Perseverance rover lands on Mars (see "Martian invasion", left) it will deploy a 0.5-metre-high drone called Ingenuity. The drone will conduct up to five flights in a 30-day window. Each will increase in duration, to a maximum of about 90 seconds.

William Farrell at NASA's Goddard Space Flight Center in Maryland and his colleagues say the flights, which are a technical demonstration, also afford a unique scientific opportunity. The low atmospheric pressure on Mars, coupled with its dusty environment and carbon dioxide-rich atmosphere, could produce an electric charge on the blades strong enough to break down atmospheric molecules, says the team (arxiv.org/abs/2102.04181).

Modelling this breakdown in the lab showed that it is unlikely to damage Ingenuity, but could be visible at take-off and landing in low light, producing a soft glow or "corona" on the

blades. Something similar, known as the Kopp-Etchells effect, can happen to helicopters on Earth.

"We suggest that operations occur once at twilight so that any corona-like glow [can] be observed by Perseverance in the low light environment," the team writes.

Perseverance will use its cameras to record Ingenuity's flights, so might be able to see this effect. Joshua Ravich at NASA's Jet Propulsion Laboratory

"We're mostly planning to fly mid-morning because of better wind conditions"

in California, the helicopter's mechanical engineering lead, says the team hasn't yet decided whether to attempt a flight at twilight. "We think that would be pretty interesting to see," he says. "Unfortunately, we're mostly planning to fly mid-morning because of better wind conditions and thermal conditions."

Even if a twilight flight were tried, Perseverance's cameras might not be sensitive enough to see the effect. "But it would be pretty cool," says Ravich. ■

The Ingenuity helicopter will take off from the Perseverance rover

