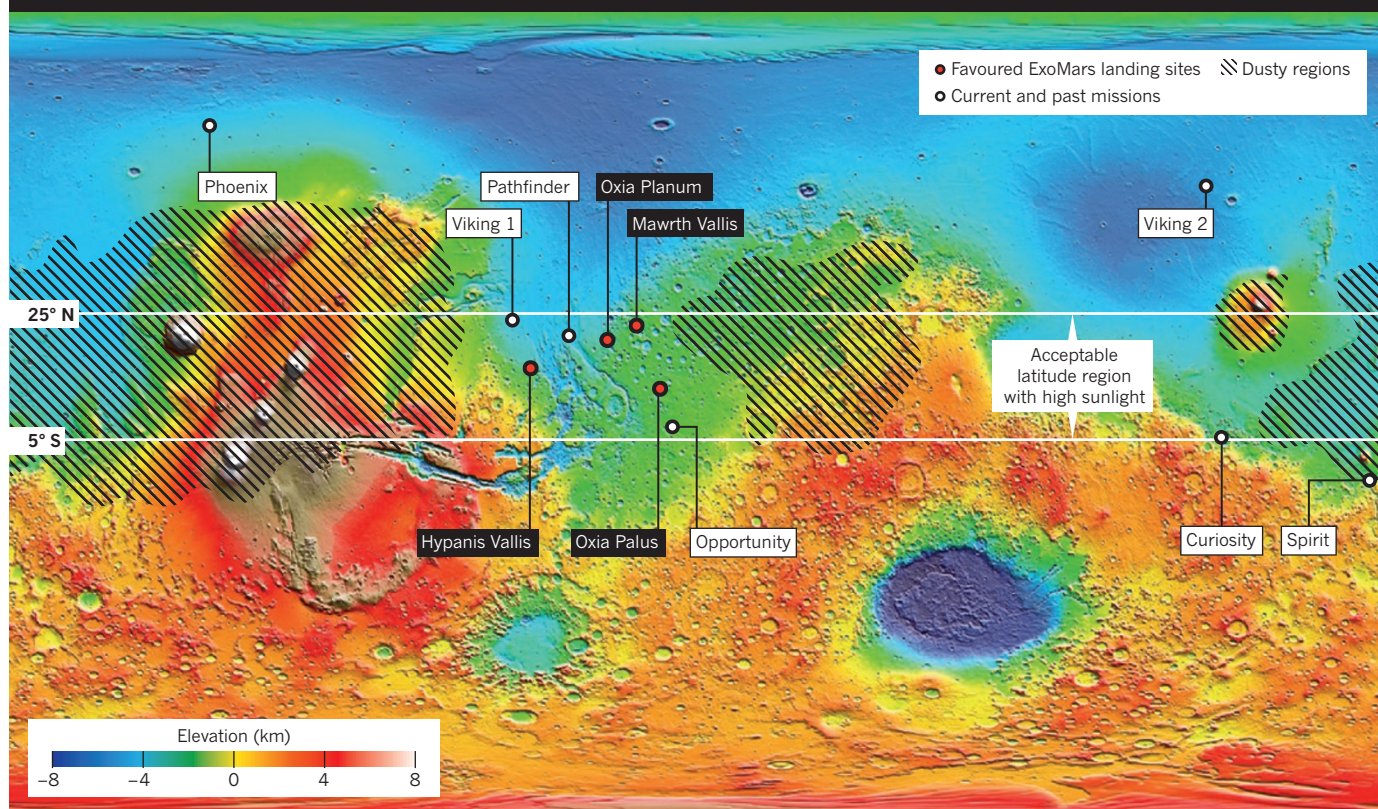


SOURCE: NASA/GODDARD SPACE FLIGHT CENTER

## HOMING IN

European scientists have selected four favourable landing sites for the ExoMars rover. The sites must satisfy three engineering requirements: a low elevation, plentiful sunlight and little dust.



## SPACE

# ExoMars scientists narrow down landing sites

*Facing engineering constraints, researchers propose four destinations for European rover.*

BY ELIZABETH GIBNEY

Scientists have picked four potential landing sites for a European rover designed to search for life on Mars. The 300-kilogram ExoMars rover, part of a joint mission of the European Space Agency (ESA) and Russia's space agency, Roscosmos, is scheduled to land on the red planet in early 2019. Armed with a drill that can bore 2 metres into rock, the rover will search for preserved organic matter that, on the surface, might have been destroyed by harsh radiation.

Last week, 60 scientists met at ESA's European Space Astronomy Centre near Madrid to discuss eight potential sites. On 27 March, they cast an informal vote, and four sites emerged as favourites: Mawrth Vallis, Oxia Planum, Hypanis Vallis and Oxia Palus (see 'Homing in'). An expert working group tasked with

recommending a final landing site will now consider the proposals, before announcing a formal shortlist of three or four sites in June. Following detailed studies of the shortlisted sites, the panel will make a single recommendation to ESA and Roscosmos in late 2016.

Finding the right spot is crucial, says Matt Balme, a planetary scientist at the Open University in Milton Keynes, UK. "If we make the wrong choice, we could land somewhere unsafe — leading to total mission failure — or land somewhere where we have no chance of meeting the science objectives of the mission," he says.

Scientific and engineering constraints already rule out much of the planet. To have a chance of finding evidence of life, working-group scientists must pick a site that would have been watery more than 3.6 billion years ago, when water is thought to have been

more abundant. They also need a site where wet sediments were quickly buried and preserved in a stack of geological layers, says ESA's ExoMars project scientist Jorge Vago, who is based at the European Space Research and Technology Centre in Noordwijk, the Netherlands. The four leading sites fall into two categories: places where there is strong mineralogical evidence for wet sediments, and places where there is strong morphological evidence for river mechanisms that would have deposited fine sediments, which are best for trapping and preserving organic materials.

Mawrth Vallis and Oxia Planum, two vast plains that contain some of the planet's oldest rocks, fall into the first category. Minerals called phyllosilicates detected from orbit indicate that the rocks were once wet clays, and that they formed in a neutral pH environment that would have been favourable for life.

Meanwhile, images from orbit show that Oxia Palus once had a meandering river channel, and that Hypanis Vallis was once a delta. Both features would have buried organic matter quickly, leading to its preservation in sedimentary rock.

“Should we go where there is evidence of a wide-scale river environment, or go where the clays are?” asks John Bridges, a planetary scientist at the University of Leicester, UK, and a member of the site-selection working group. “There are good arguments both ways.”

Jack Mustard, a geologist at Brown University in Providence, Rhode Island, and former chair of NASA’s Mars advisory group, says that the best place to find signs of life will be somewhere with a long history of flowing water. “You want to be in a place where water would have been around long enough to have captured the spark of life, should it have ever started,” he says. For this, he adds, Mawrth Vallis “stands out”, because its chemistry suggests that the region held water for an extended time. The site narrowly missed out on being the destination for NASA’s Curiosity rover, which landed in Gale Crater in 2012.

But before ExoMars can begin to test for life, it has to land safely. Responsibility for the landing system lies with Roscosmos, which signed up to the project last year after NASA dropped out in 2011 (see *Nature* <http://doi.org/bwd9hh>; 2011). Russia’s expertise is built

**“Should we go where there is evidence of a wide-scale river environment, or go where the clays are?”**

mostly on its success with lunar landers in the 1960s and 70s. Vago says that the team will get to test its technology with a trial lander — the ExoMars Entry, Descent and Landing Demonstrator Module — in 2016, before the main mission.

The landing technology is already limiting the number of viable sites. ExoMars will use a heat shield and parachutes to pass through the thin atmosphere. It needs to travel through as much atmosphere as possible to slow it down sufficiently for a safe landing, so the landing zone must be low-lying. Furthermore, unlike the radioisotope-powered Curiosity, the rover will run solely on solar energy. That means

that only dust-free and sunny destinations, not too far from the equator, will do.

The landing window for ExoMars, given the uncertainties in its trajectory, is an ellipse 104 kilometres long and 19 kilometres wide — more than ten times the area of the window for Curiosity, which had the ability to land more precisely. This entire site must be mostly clear of large boulders and craters. Yet because the ExoMars rover will travel only a few kilometres in total, its path must contain scientifically interesting sites throughout. Over the next month, the working group will try to find the best landing ellipse for each site, says Vago.

NASA, for its part, will in May begin the process of picking a destination for its next Mars rover, scheduled for launch in 2020. Getting the data needed to evaluate sites for both ExoMars and the 2020 rover will be a race against time, says Mustard. NASA’s Mars Reconnaissance Orbiter, which has done the lion’s share of the high-resolution spectroscopy and imaging of the landing sites, is now nine years old, and starting to suffer from technical glitches. “The idea is to get the data before the pieces start falling off,” says Mustard. ■

## CLIMATE

# El Niño tests forecasters

*As hints emerge of a major weather event this year, poor data could thwart attempts to improve predictions.*

BY JEFF TOLLEFSON

The first sign of a brewing El Niño weather pattern came in January, as trade winds that normally blow from the east reversed course near Papua New Guinea. Barrelling back across the tropical Pacific Ocean, they began to push warm water towards South America. Now climate scientists and forecasters are on high alert.

A major El Niño event — a periodic warming of waters in the eastern equatorial Pacific — could boost temperatures and scramble weather worldwide. The most recent major event, in 1997–98, was linked to thousands of deaths and tens of billions of dollars in damage from droughts, fires and floods across several continents. Yet more than 15 years later, forecasting the timing and intensity of El Niño remains tricky, with incremental improvements in climate models threatened by the partial collapse of an ocean-monitoring system that delivers the data to feed those models.

El Niño often emerges during the Northern Hemisphere summer and peaks around December; forecast models can do a reasonable

job of predicting its eventual strength by July, when the changes in ocean circulation that give rise to the weather pattern have become pronounced. But scientists are working feverishly to provide earlier forecasts, to allow governments more time to prepare for potentially devastating weather patterns.

In 1997, the emergence of a record-breaking El Niño caught scientists by surprise, despite hints in wind and sea surface temperature data (see ‘Warming up’). The European Centre for Medium-Range Weather Forecasts in Reading, UK, was reluctant to issue early warnings because its forecast model was untested. And the model that had best predicted earlier El Niños — developed by scientists at Columbia University’s Lamont–Doherty Earth Observatory in Palisades, New York — foresaw neutral conditions.

“We were in the early days in forecasting,” says Michael McPhaden, an oceanographer at the US National Oceanic and Atmospheric Administration (NOAA) in Seattle, Washington. “Now we are much more systematic.”

This year, NOAA issued its first forecast on 6 March, estimating a 50% chance that El Niño

will develop this summer. But that early projection, and others from weather agencies and research institutions around the world, comes with lots of uncertainty. Fickle tropical winds in spring can easily quash a brewing El Niño — or strengthen it.

Researchers say that real progress in forecasting has come from systematically comparing the outputs of groups of models, with each simulation run under a range of possible climate conditions. “Combining these various predictions — doing some crowd-sourcing, if you will — tends to lead to more reliable predictions,” says Gabriel Vecchi, a climate modeller at NOAA’s Geophysical Fluid Dynamics Laboratory in Princeton, New Jersey. Averaging the results of several different forecasting models tends to cancel out flaws in an individual program, he says.

The sensitivity of the simulations is also increasing. Global climate models divide the planet into grids, like a computer screen divided into pixels, and represent climate variables such as temperature as averages in each cell. Modellers increase the resolution of their calculations by reducing the size of the cells.