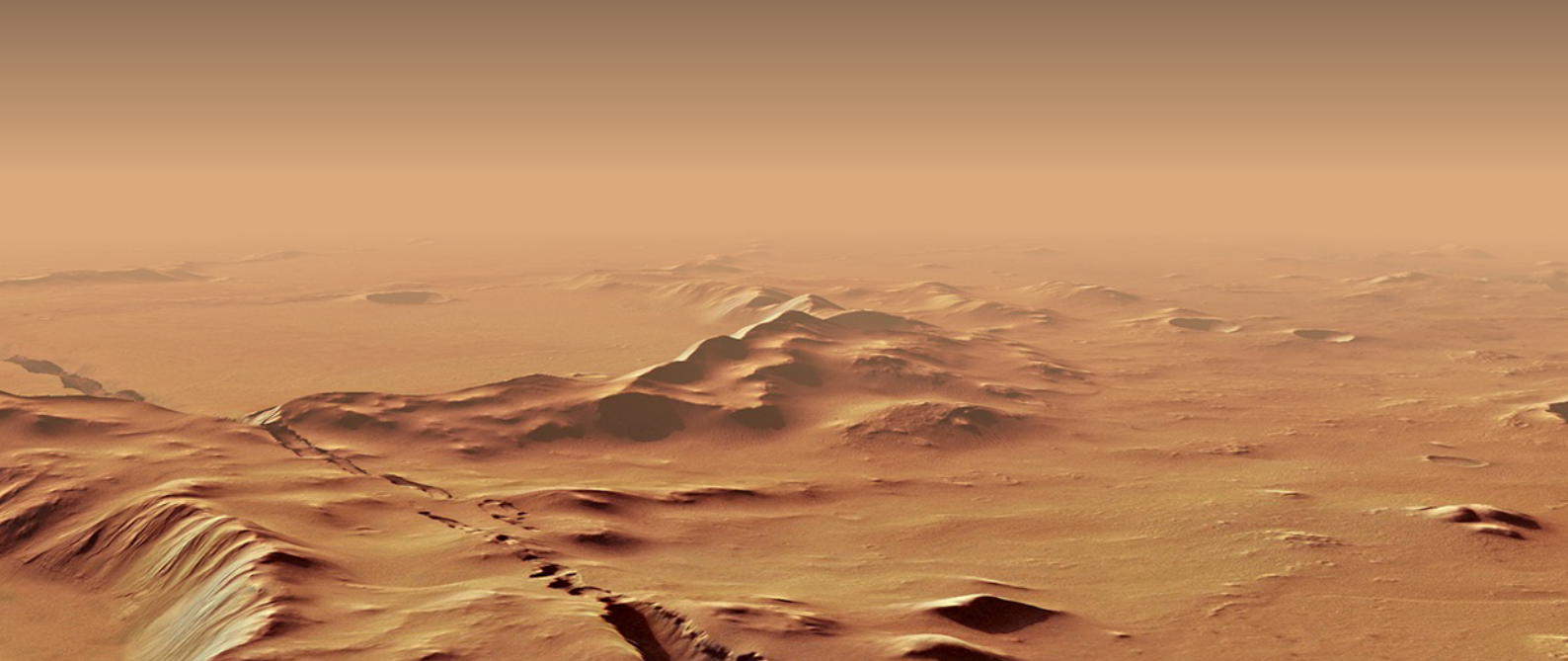
All About Space

EXPLORER'S GUIDE TO MARS



Explorer's Guide Mars

Mars is a fascinating place to explore due to its amazing geology and potential for ancient life

Mars is the fourth planet from the Sun and the most Earth-like of the Solar System's other worlds. Following a distinctly elliptical orbit a little way beyond Earth, it is the outermost of the terrestrial planets: beyond it lies the asteroid belt and then the realm of giant planets in the Solar System's outer reaches.

But Mars is very different from Earth: its small size, low gravity (about 38 per cent of Earth's), cold average temperatures of around -60 degrees Celsius (-76 degrees Fahrenheit) and a very thin atmosphere that exerts about one per cent of Earth's atmospheric pressure, means that liquid water can't survive for very long on the surface. So the planet today is a cold, dry desert. Nevertheless, large quantities of frozen water are trapped in its icy polar caps and in the upper layers of its red soil, within a permafrost that extends down to mid-latitudes in both hemispheres. Thanks to a tilted axis of rotation, Mars goes through a cycle of seasons similar to Earth's, as first one pole and then the other receives more sunlight. But astronomers believe that changes to Mars' orbital characteristics create long-term cycles in the climate – it may have been significantly warmer and wetter in its past and the Red Planet has the potential to be more hospitable again in the future.

Much further back in its history there's evidence that Mars was rich in surface water, with a thicker atmosphere and a vast ocean covering much of its northern hemisphere. Today, the ocean floor survives in the form of vast, relatively smooth lowland plains that dominate the planet's northern half, while heavily cratered highlands cover the southern hemisphere. It's even possible that conditions could once have been suitable for the development of ancient microbial life, though so far this remains unproven.

How to get there

1. Departing Earth
Any trip to Mars needs to depart around the time of opposition, when both Earth and Mars are roughly lined up on the same side of the Sun and the distance between them is at a minimum.

2. Short hop
The average Earth-Mars distance at opposition is 77 million km (48 million mi), though the distance travelled along a smooth transfer orbit could be up to 100 million km (62 million mi), taking about six months with currently feasible technology.

3. Arrival at Mars
The crewed spacecraft to Mars would probably be relatively small, with most of the equipment needed to survive and work on the surface placed on the surface months or years before by automated missions.

4. Long stay
By the time the spacecraft arrives, Mars and Earth will be drifting out of alignment and the distance between them increasing, so Martian astronauts would probably plan to stay on the surface for up to two years until the next opposition.

5. Return journey
The crew blast off for home in a spaceship previously landed by a robotic mission, and probably powered by rocket fuel manufactured on Mars using ice from the soil.

Northern polar cap

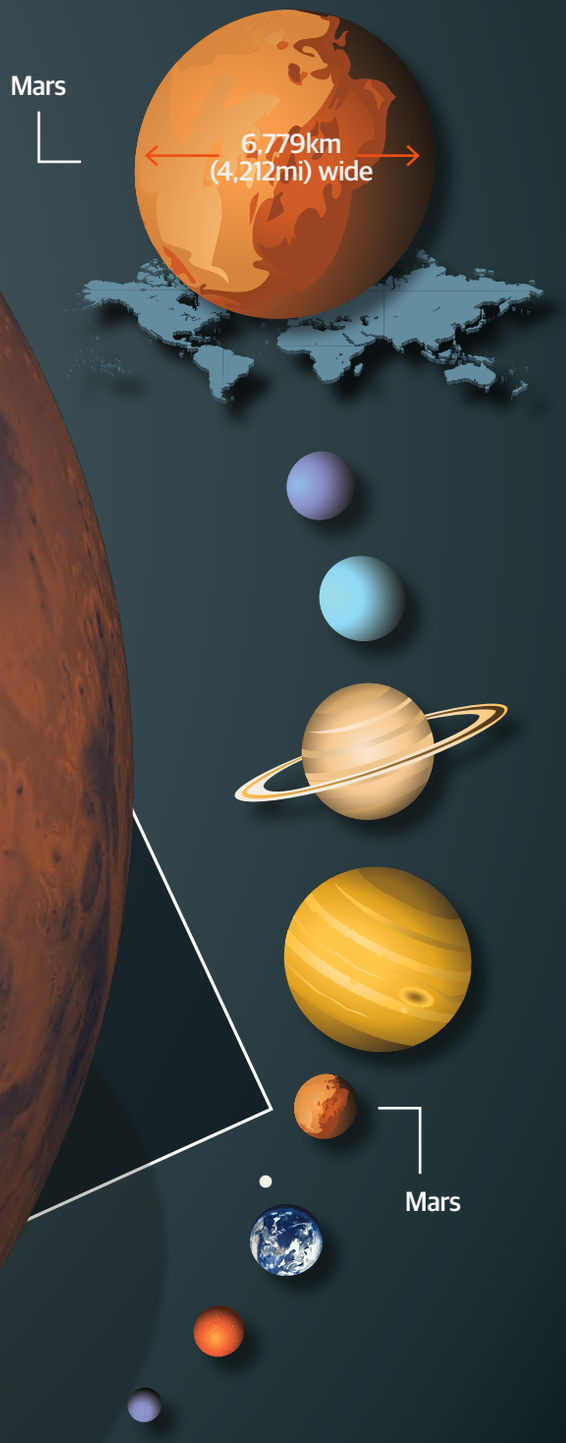
Northern plains

Valles Marineris

Southern highlands

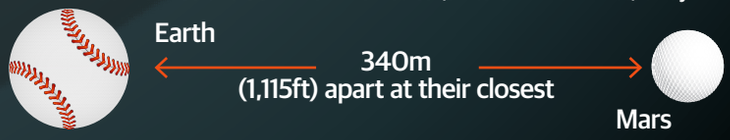
How big is Mars?

With a diameter of 6,779 kilometres (4,212 miles), Mars is slightly more than half the size of Earth: its surface area is 98 per cent of Earth's dry land.



How far is Mars?

The distance to Mars can vary hugely. Even when the planets line up on the same side of the Sun, its elliptical orbit means that it can be anything between 55 and 99 million kilometres (34 to 61 million miles) away.



Top sights to see on Mars

Despite being a small planet, Mars is home to some supersized geography. Its most famous feature is the towering peak of Olympus Mons, a vast shield volcano with a shallow, dome-like profile some 600 kilometres (373 miles) in diameter, created by the eruption of layers of lava through widespread volcanic fissures over hundreds of millions of years. At its peak, 25 kilometres (16 miles) above the average Martian surface datum (the Martian equivalent of sea level), an overlapping group of pits forms a central caldera up to 80 kilometres (50 miles) across.

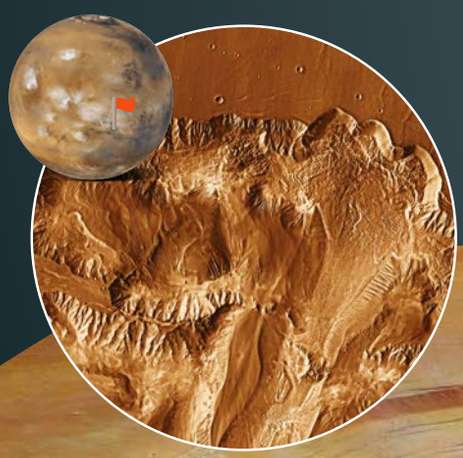
Olympus Mons is just the most prominent of many volcanoes: to its southeast lies an enormous bulge in the planet's surface, known as the Tharsis Rise. This vast plateau straddles the Martian equator at an average of eight kilometres (five miles) above the surface datum and is home to a chain of three volcanic peaks known as Tharsis Montes. Just as impressive is a deep, broad trench that runs from east to west, beginning to the southeast of the Tharsis Rise. This enormous rift, known as the Valles Marineris, is more than 4,000 kilometres (2,485 miles) long, seven kilometres (four miles) deep in places, and consists of parallel trenches with a total span of 200 kilometres (124 miles) or more. Unlike Earth's far smaller Grand Canyon, the Valles Marineris formed not through erosion by water but instead along an enormous tectonic fault.

The northern plains of Mars are a dusty desert coloured by reddish sands rich in iron oxide (the same chemical that forms rust on Earth), but the southern highlands are densely cratered and home to winding valleys where ancient, liquid water once flowed.

Close to the Martian poles, the red soil of the highlands bear an unmistakable resemblance to Earth's glaciers, and recent space probe images suggest this is exactly what they are – slow-moving but unstoppable masses of ice disguised beneath a thin layer of reddish dust. In winter they are often covered by a bright frost of frozen carbon dioxide from the Martian atmosphere, while in summer only the colder 'residual polar cap', made largely of water ice, persists, displaying swirling patterns created by the sculpting effect of polar winds over millions of years.

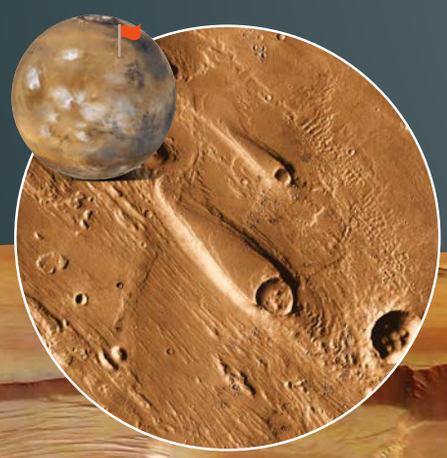
Ophir Chasma

The central regions of the Valles Marineris once suffered a long, slow collapse that created this enormous valley, some 100km (62mi) wide, in the middle of the great rift valley.



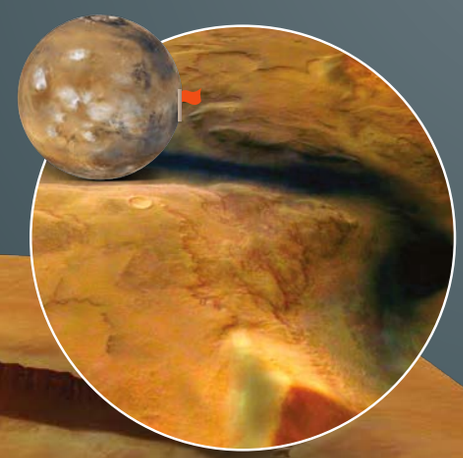
Ares Vallis

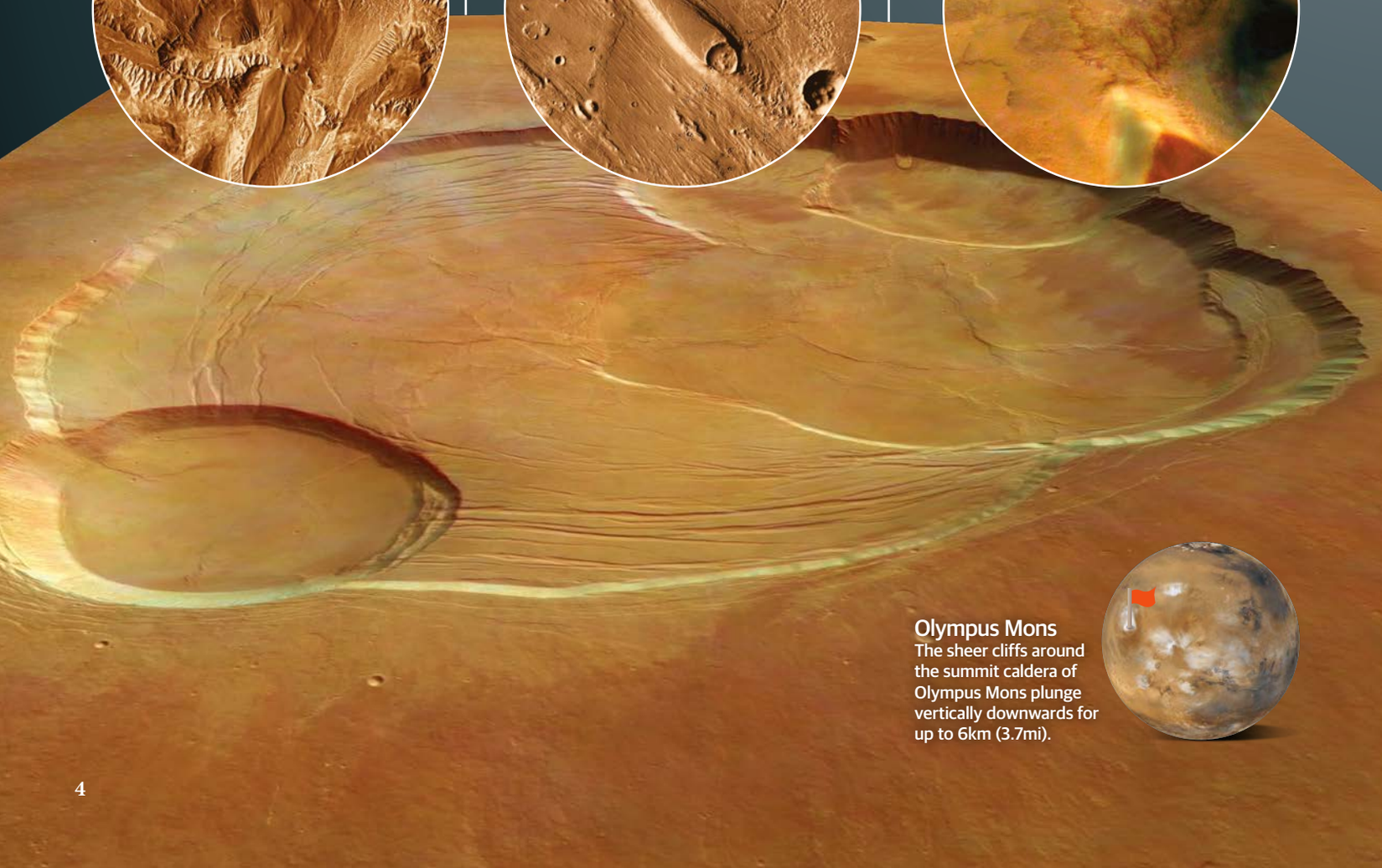
Water escaping from beneath the surface of the highland regions in a catastrophic event shaped this landscape on the edge of the northern plains, carving islands that survive billions of years later.



Winding rivers

Sinuous valleys such as Reull Vallis, which runs westward into Hellas Planitia, bear the unmistakable signs that they were formed by water, flowing on the Martian surface over a long period of time.





Olympus Mons

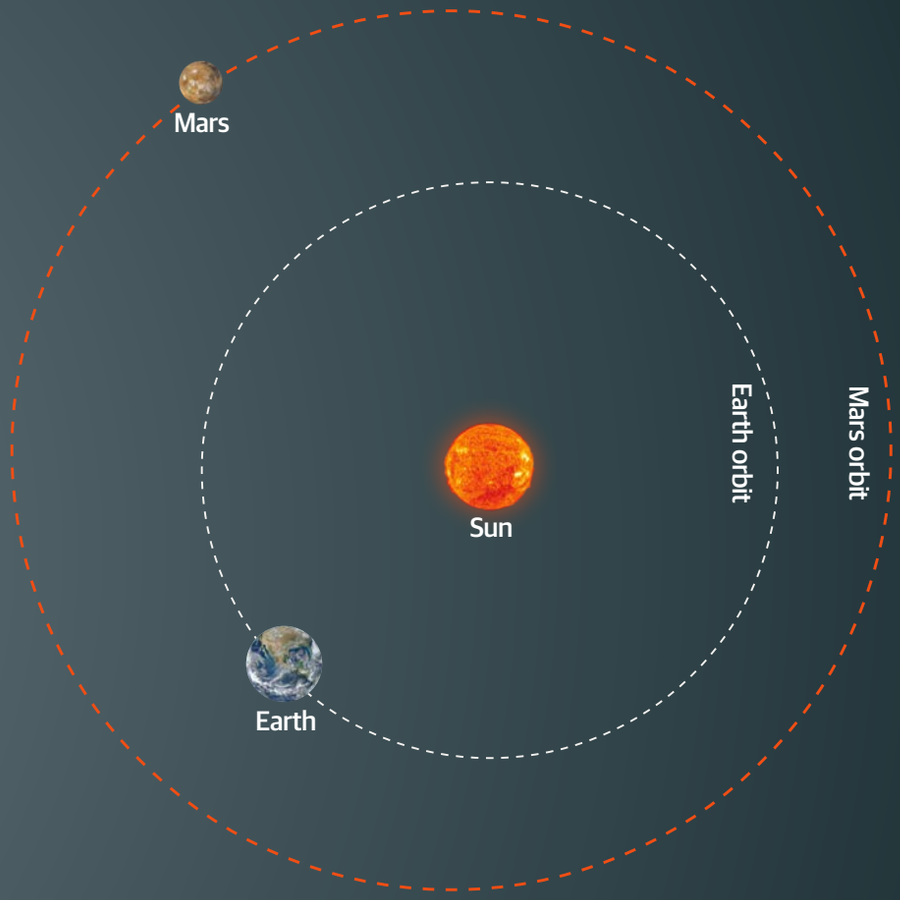
The sheer cliffs around the summit caldera of Olympus Mons plunge vertically downwards for up to 6km (3.7mi).

Mars's orbit

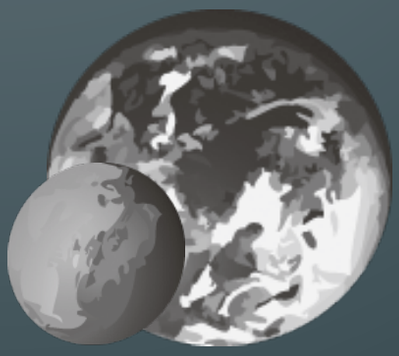
Mars orbits the Sun once every 687 days, at an average distance of 228 million kilometres (142 million miles – just over 1.5 times the Earth-Sun distance). However, its orbit is markedly elliptical, so its distance from the Sun actually varies between around 207 and 249 million kilometres (129 to 155 million miles). The tilt of the planet's axis means that it is closest to the Sun during southern summer and furthest away during northern winter, exaggerating the effect of these seasons.

1 Earth year = 365 days
1 Mars year = 687 Earth days or 669 sols (Martian days)

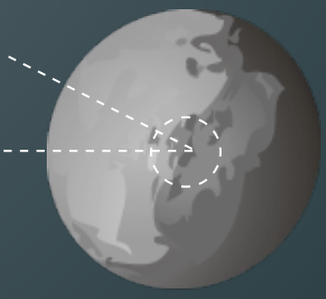
A sunset on Mars, taken by the NASA rover Spirit



Mars in numbers



25.2 Current angle of Mars's axial tilt in degrees (Earth's is 23.4)



Weather forecast

20°C
-153°C

Mars has complex weather, with snowfalls of frozen carbon dioxide at polar latitudes each autumn, occasional clouds of both water ice and carbon dioxide, and above all, powerful dust storms that can sometimes engulf the entire planet in an orange haze for months.

0.107 *Mass of Mars compared to Earth*

24.1 *The planet's average orbital speed in kilometres per second*

780 The average number of days taken for Earth and Mars to return to opposition

95.3% *Percentage of carbon dioxide in the Martian atmosphere*

20 *Estimated top temperature on Mars in Celsius*

The length of a Martian day in hours