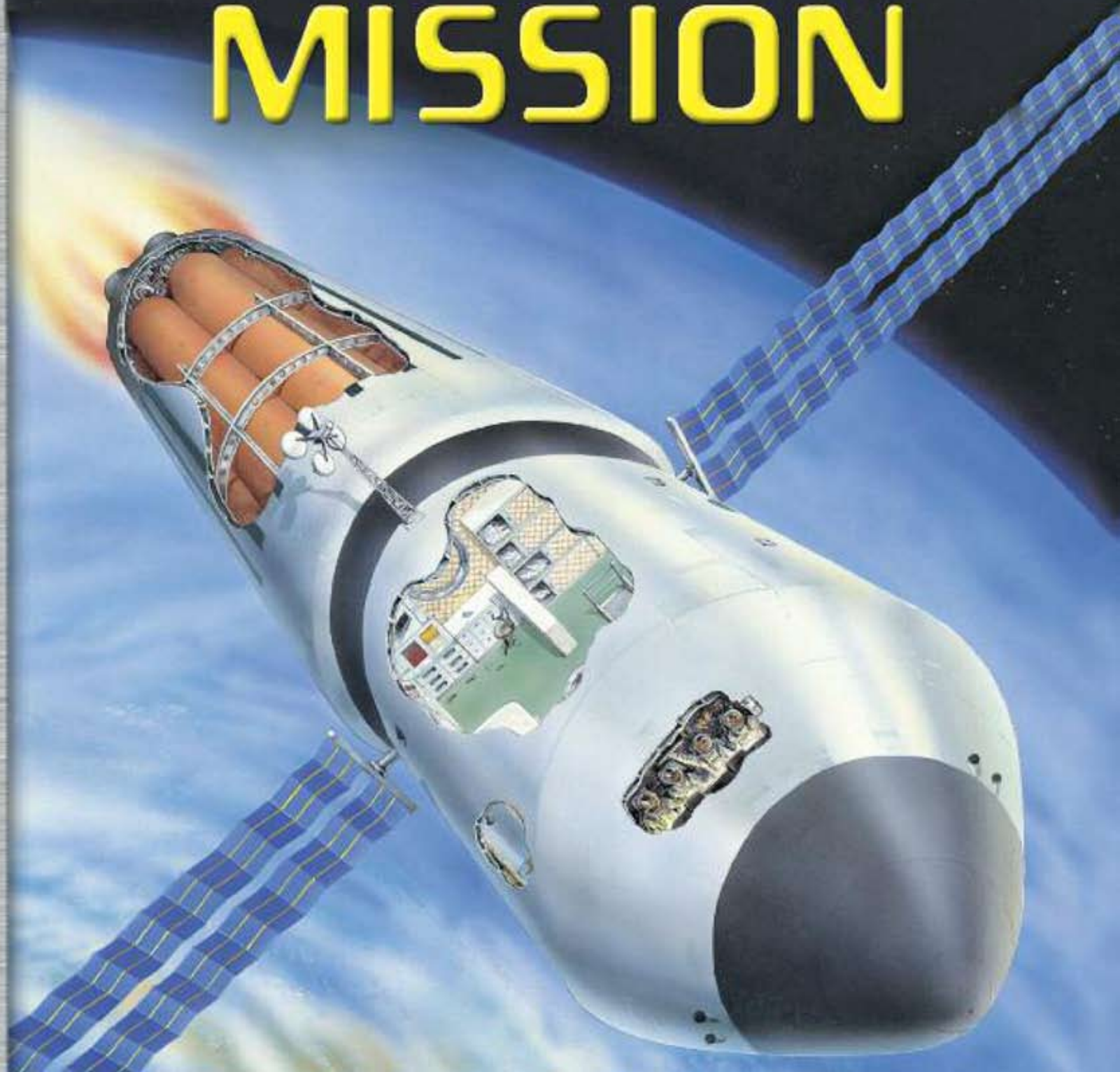
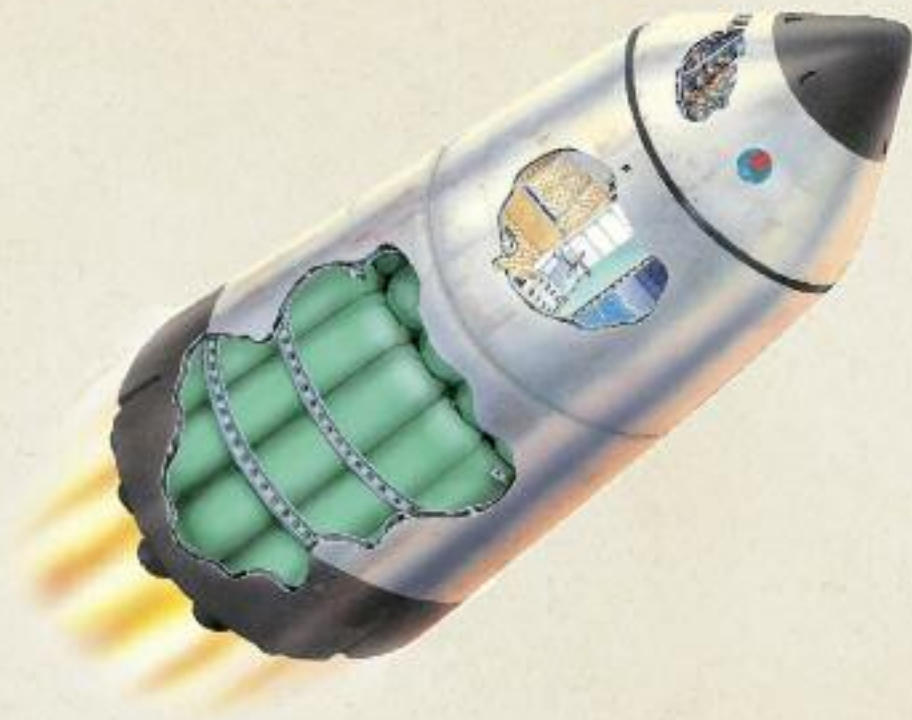


The story of a
**SPACE
MISSION**



The story of a SPACE MISSION



illustrated by
Peter Dennis

 Orpheus

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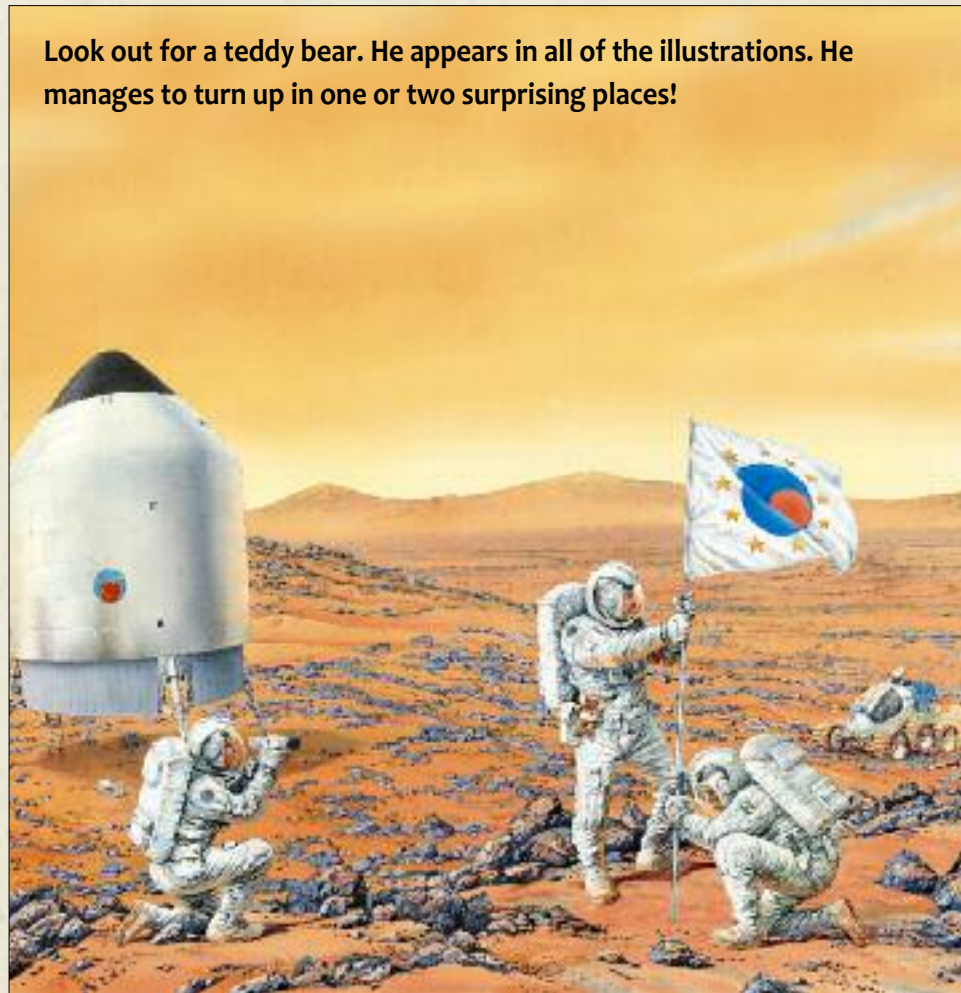
Consultant David Hawksett, Organiser of the UK Planetary Forum

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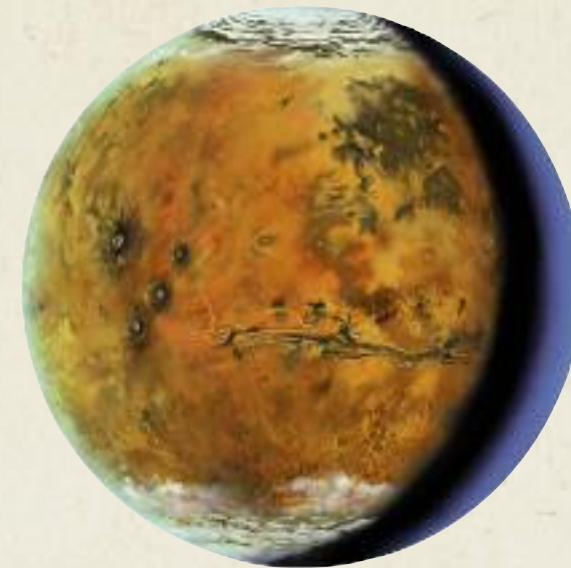
Look out for a teddy bear. He appears in all of the illustrations. He manages to turn up in one or two surprising places!



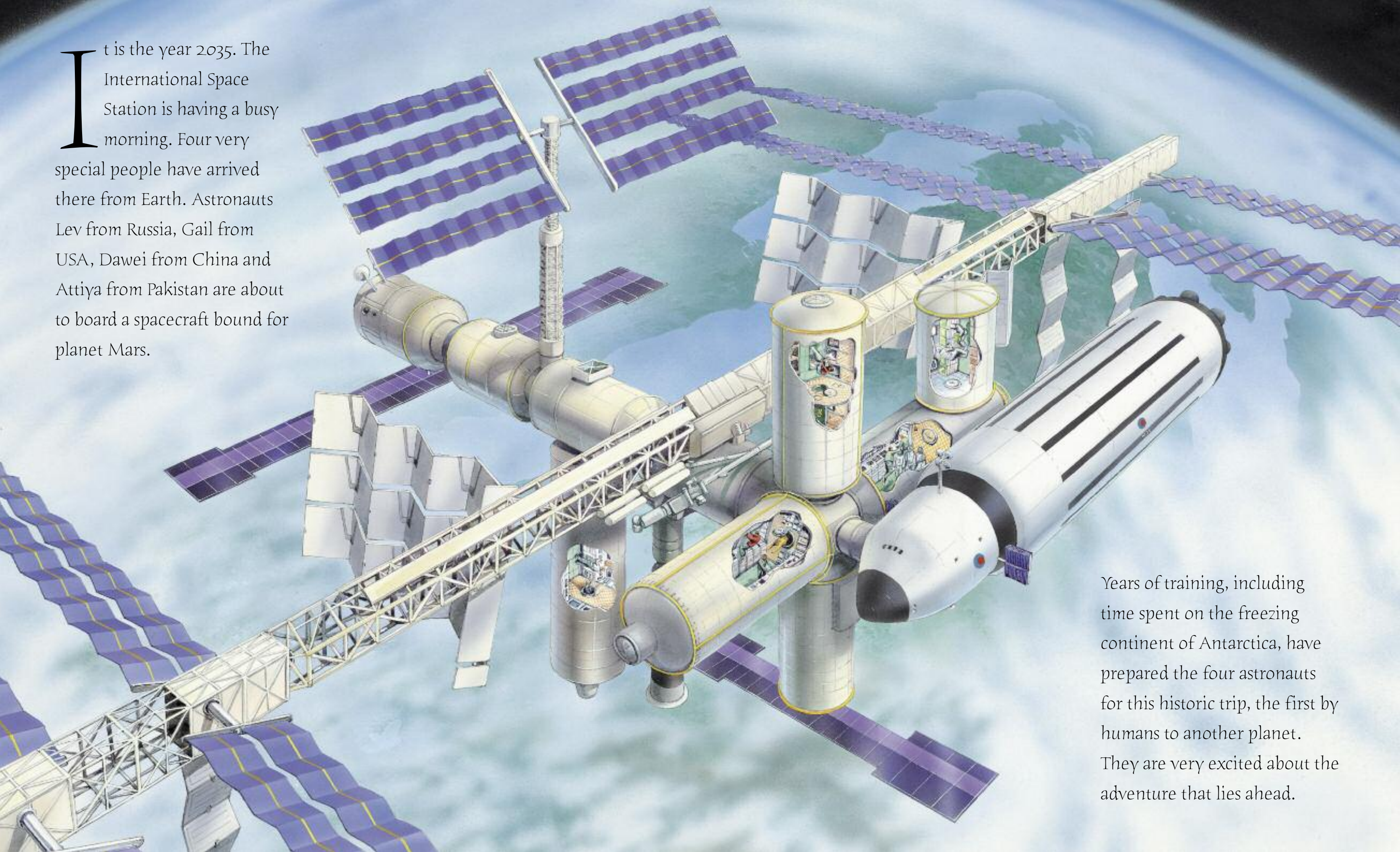
THE RED PLANET

Mars is the fourth planet from the Sun. Its reddish colour comes from the iron oxide dust (familiar to us as rust) that blankets the planet. Water ice is found on Mars at its two polar icecaps or in a frozen layer just beneath the ground.

The presence of river beds on Mars has convinced scientists that water once flowed there. Mars, long ago, might have been a warmer, wetter planet than it is today. Liquid water might even be still seeping out of the ground, forming mudflows. And wherever there is water, life could exist. There is only one way to find out: to send a manned mission to Mars.



It is the year 2035. The International Space Station is having a busy morning. Four very special people have arrived there from Earth. Astronauts Lev from Russia, Gail from USA, Dawei from China and Attiya from Pakistan are about to board a spacecraft bound for planet Mars.



Years of training, including time spent on the freezing continent of Antarctica, have prepared the four astronauts for this historic trip, the first by humans to another planet. They are very excited about the adventure that lies ahead.

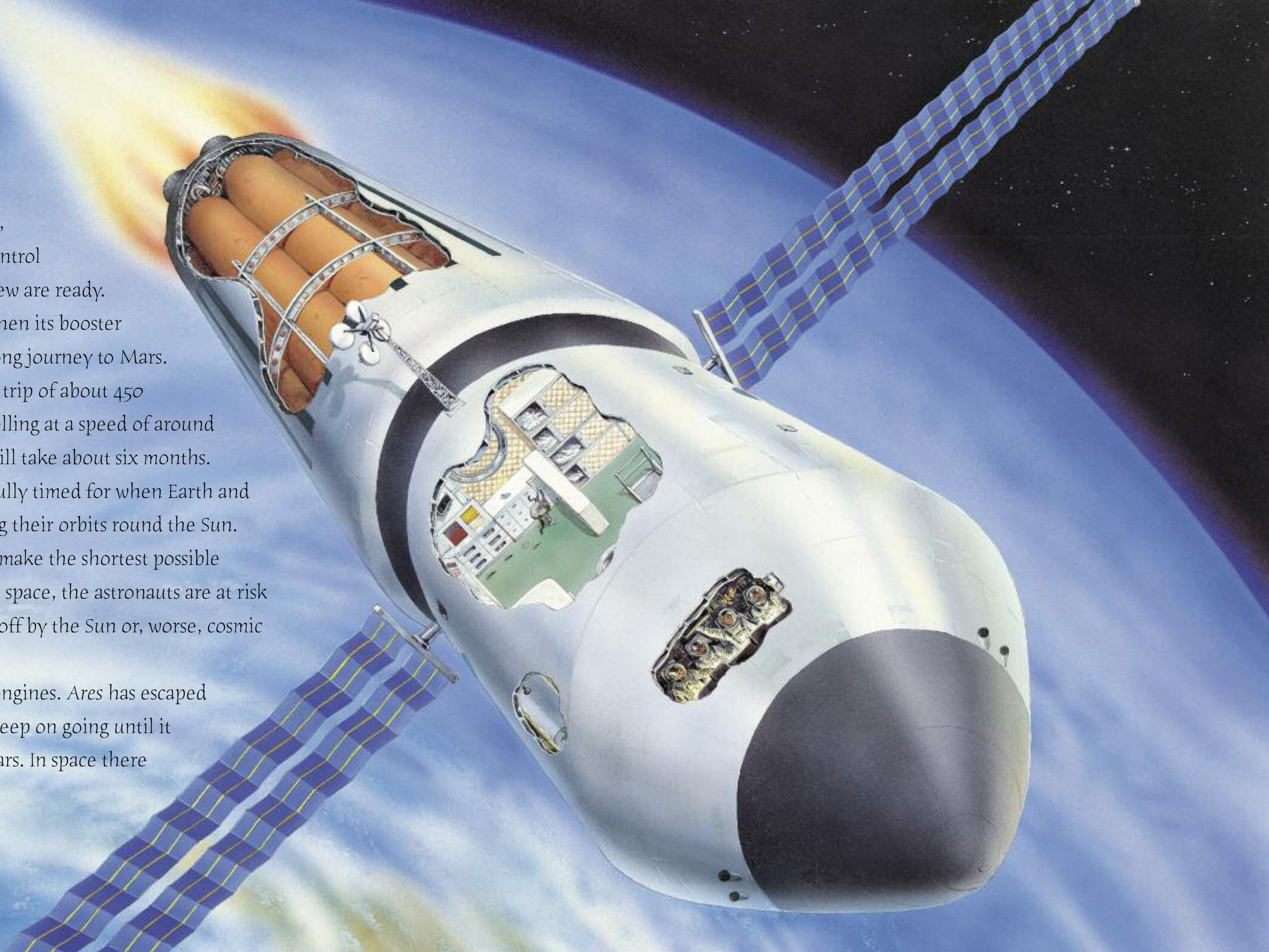
A

few days
later, Lev,
commander
of the

spacecraft *Ares* (in which the astronauts will travel to Mars), speaks by radio to Mission Control based on Earth. He and his crew are ready. *Ares* separates from the ISS. Then its booster rockets fire and it begins its long journey to Mars. Ahead of the astronauts lies a trip of about 450 million kilometres. Even travelling at a speed of around 100,000 km/h, the journey will take about six months.

The mission has been carefully timed for when Earth and Mars are close together during their orbits round the Sun. This means that the crew will make the shortest possible flight. While they are in open space, the astronauts are at risk from harmful radiation given off by the Sun or, worse, cosmic rays from deeper space.

Soon, Lev switches off the engines. *Ares* has escaped from Earth's gravity and will keep on going until it reaches the atmosphere of Mars. In space there is no air to slow it down.



Two months later, Ares is already millions of kilometres from Earth. Radio messages to and from Mission Control take a few minutes. But the astronauts are too busy to miss home.

The first thing they have had to get used to is weightlessness. Gail and Dawei felt sick at first, but, thanks to their training, they quickly recovered. Now Gail happily floats around the cabin. Dawei trains his digital camera through one of the portholes to get a good close-up view of Mars.

After a while, the astronauts' bones and muscles could be weakened by weightlessness. So it is very important that they take plenty of exercise. Lev keeps fit by training on the moving walkway.

The toilet and shower on board Ares are specially built so that they can be used in space. All water and waste is purified and recycled. Computers are in control. They keep the cabin free of problems and, in an emergency, can even help one crew member carry out a medical operation on another.



At last, after another four months travelling, Ares and her crew are nearly there. In recent weeks, the Red Planet has loomed larger and larger in the window. Now it stretches out before them.

Before landing, Ares must slow down. It is turned so that its base, protected by a heat shield, points towards Mars, then it dips into the Martian atmosphere. This is denser than empty space, so Ares loses speed. This is called aerobraking.

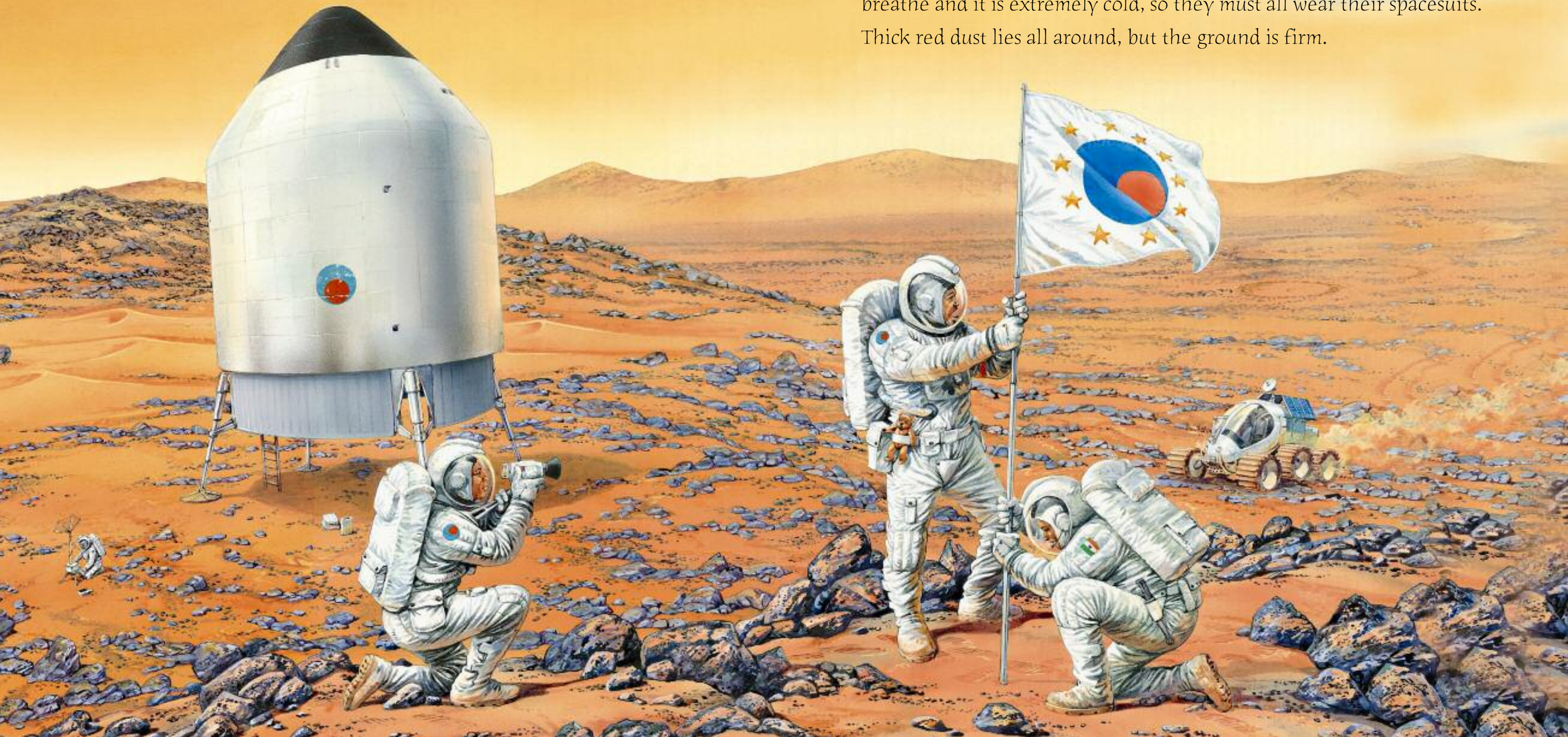
Now Ares goes into orbit round Mars. When it has slowed down enough, the heat shield is cast off and parachutes open up. The spacecraft floats down to the surface. Small rockets fire to steer it accurately to the best landing site.



Through the window, the astronauts see a wide plain with hills in the distance. There are boulders everywhere. It is completely barren. Everyone is excited as Lev climbs down the ladder. As he places his foot on the ground, he tells the billions of people watching on television back on Earth what a historic moment this is.

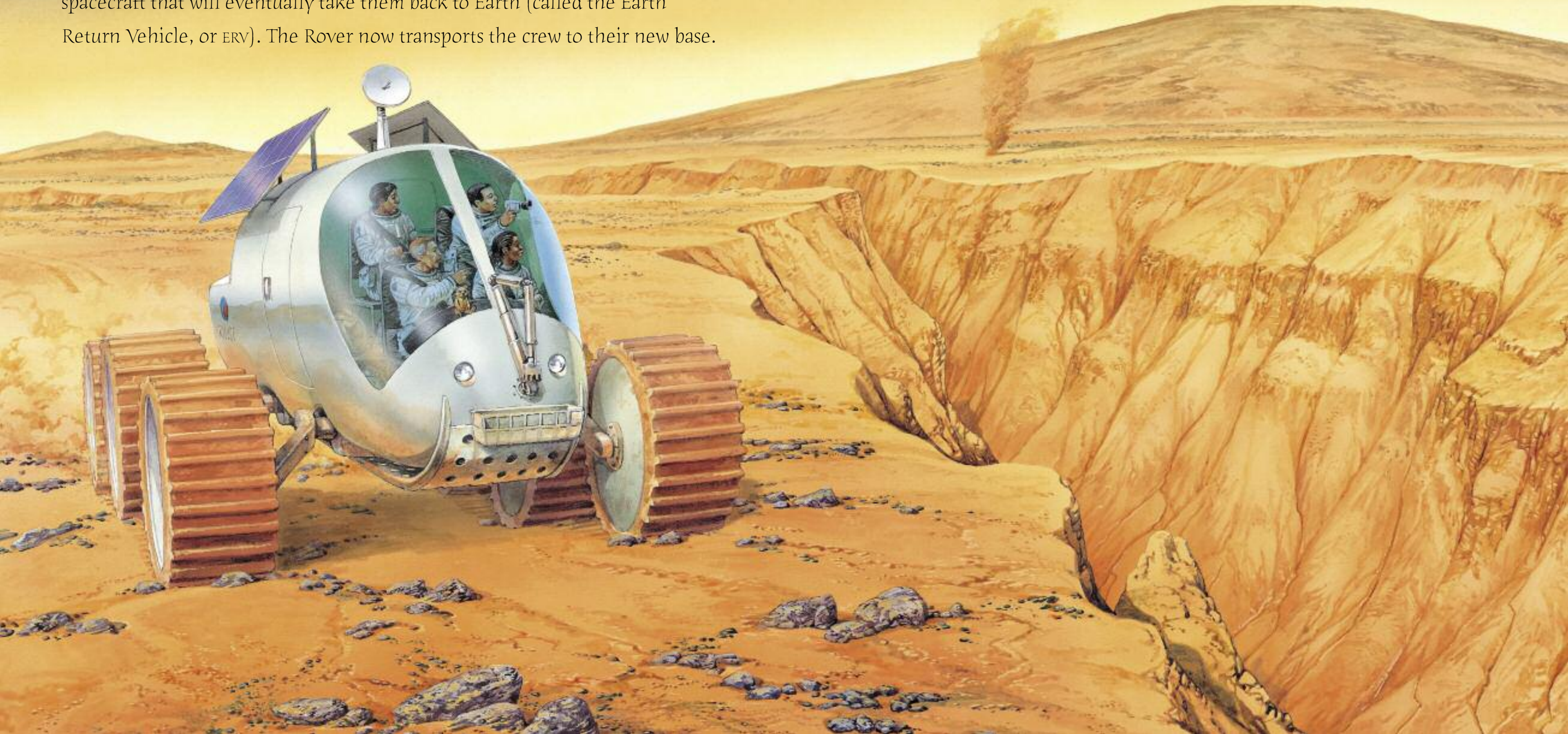
Lev is the first person ever to set foot on another planet. He is followed by all the others. While Dawei sets up a television transmitter, Lev and Attiya plant the flag of Planet Earth into Martian soil.

Gravity on Mars is about a third of what it is on Earth, so the crew feel lighter on their feet than at home. But there is no oxygen to breathe and it is extremely cold, so they must all wear their spacesuits. Thick red dust lies all around, but the ground is firm.



The astronauts' Rover, a car operated by remote control from Earth, arrives a few hours later. Ares touched down a few kilometres away from the place where the crew will live on Mars. Their home (called the "habitat" module) was sent to Mars during an unmanned mission some months earlier, along with the Rover and another spacecraft that will eventually take them back to Earth (called the Earth Return Vehicle, or ERV). The Rover now transports the crew to their new base.

The astronauts travel in the Rover across the Martian barren, but spectacular, landscape. They see some amazing sights. Mars has vast plains, but it is also a world of gigantic volcanoes and mighty canyons. They spot a small dust tornado in the distance.

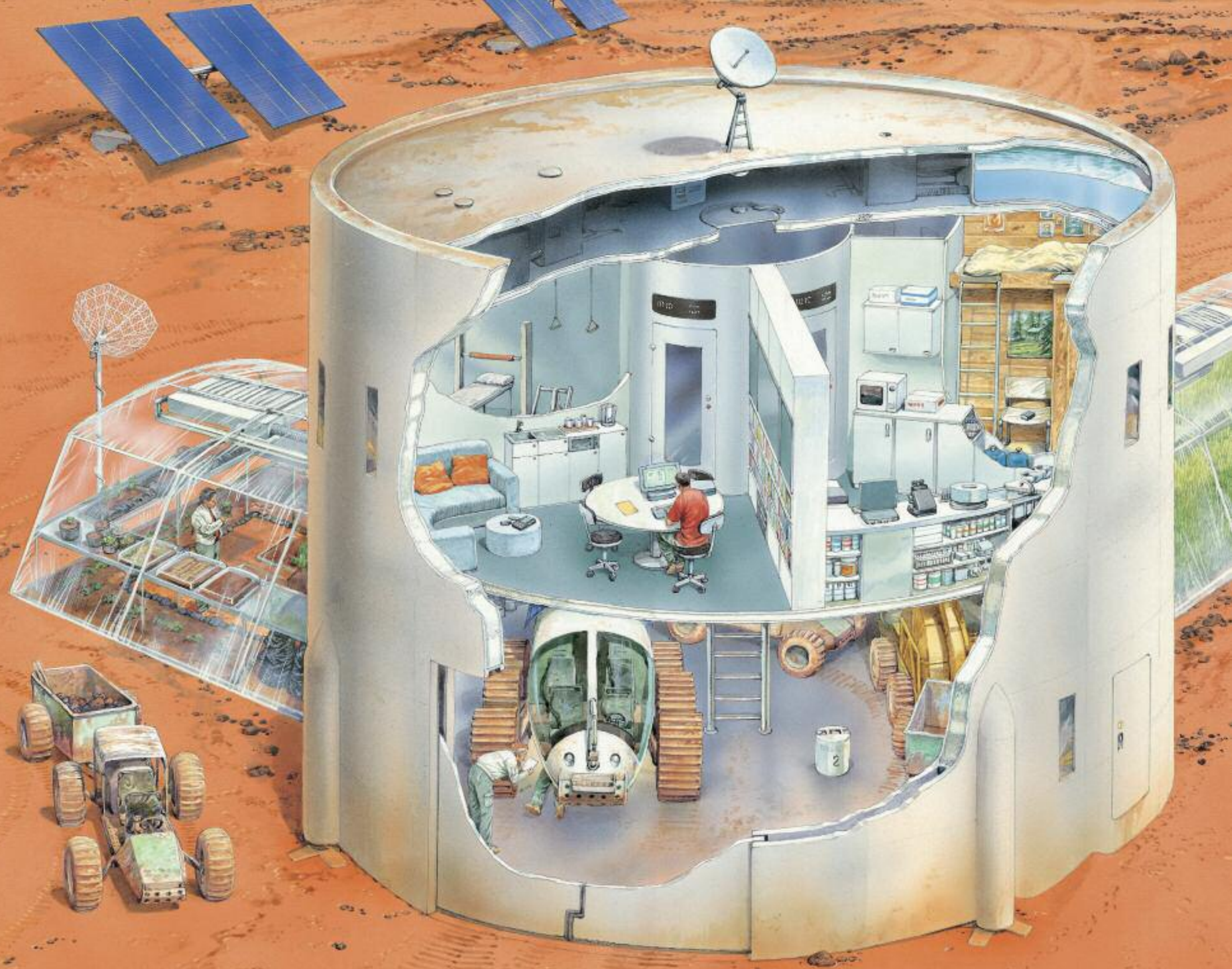


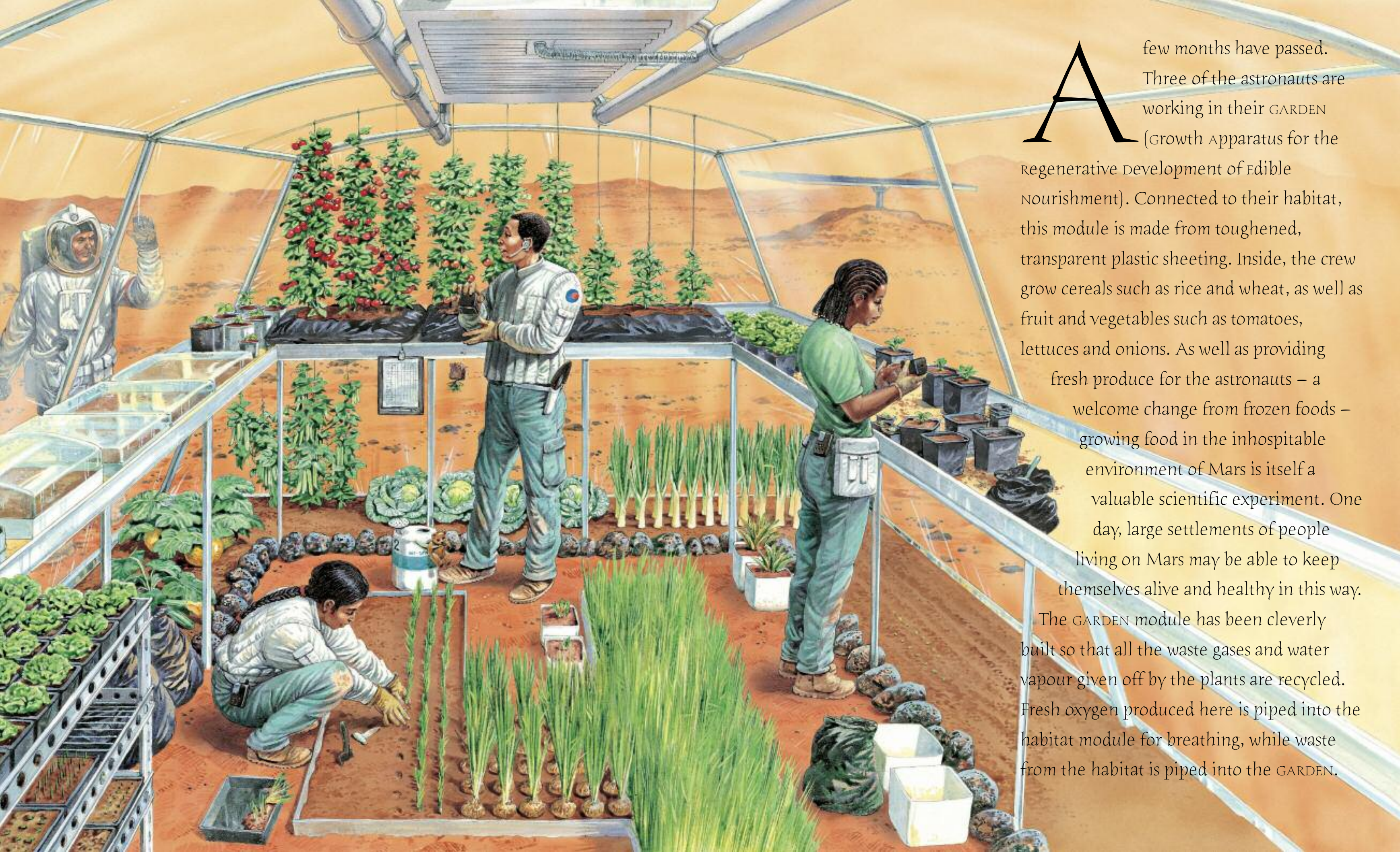
Home sweet home! The habitat has been designed to make living in a lonely, world as comfortable as possible for the crew. They have been on Mars for a month now. Dawei sends messages back home, describing what it is like to live on Mars.

The habitat module has two decks. The upper deck has bedrooms, a gym, a bathroom, a living area and a kitchen. Although most of their food – sent on before them – is frozen, the crew eat fresh fruit and vegetables they have grown. They bake their own bread.

Also on the upper deck there is a laboratory, stocked with scientific equipment. Computers maintain a constant temperature and monitor oxygen levels in the habitat.

A central staircase leads down to the lower deck. Here there is a garage for the Rovers (including two single-person models). Outside, a solar power plant uses energy from the Sun to provide electricity for the habitat.



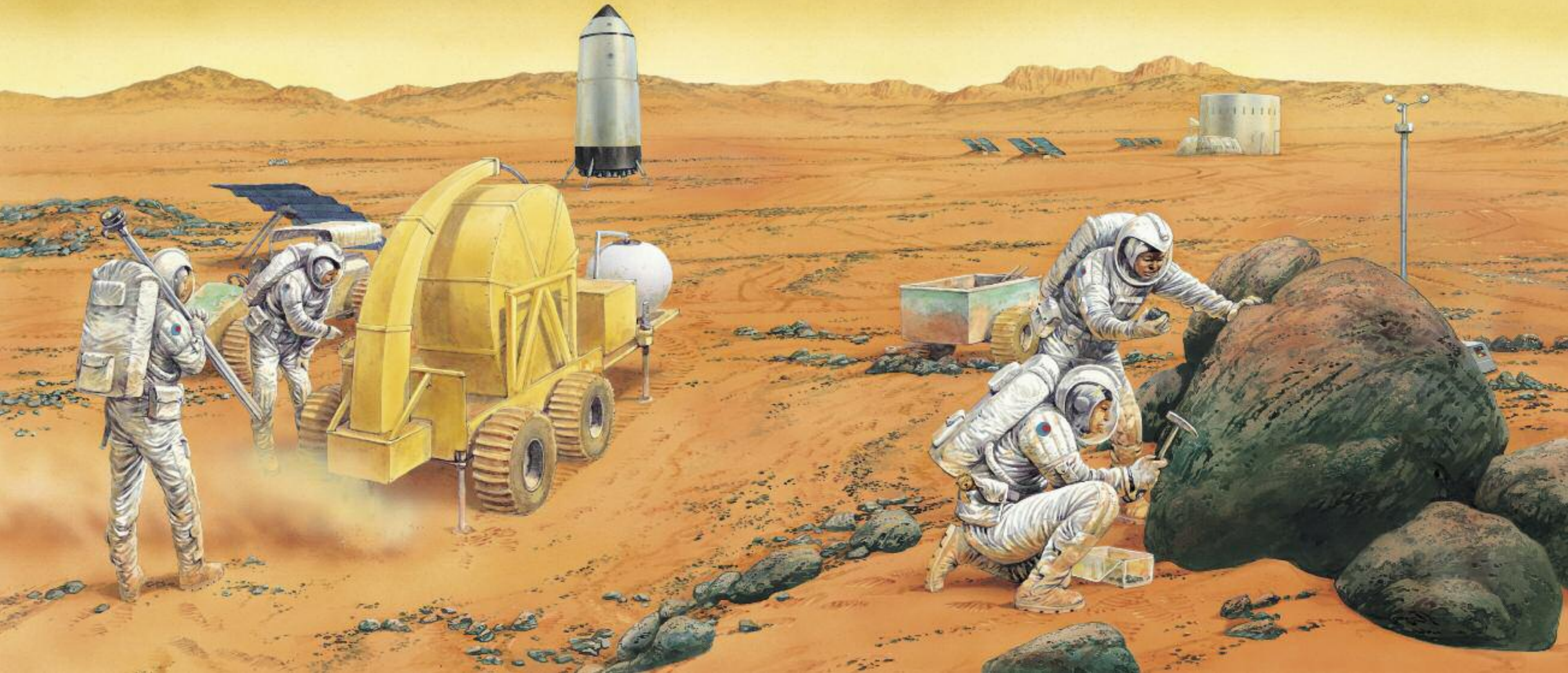


A few months have passed. Three of the astronauts are working in their GARDEN (Growth Apparatus for the Regenerative Development of Edible Nourishment). Connected to their habitat, this module is made from toughened, transparent plastic sheeting. Inside, the crew grow cereals such as rice and wheat, as well as fruit and vegetables such as tomatoes, lettuces and onions. As well as providing fresh produce for the astronauts – a welcome change from frozen foods – growing food in the inhospitable environment of Mars is itself a valuable scientific experiment. One day, large settlements of people living on Mars may be able to keep themselves alive and healthy in this way. The GARDEN module has been cleverly built so that all the waste gases and water vapour given off by the plants are recycled. Fresh oxygen produced here is piped into the habitat module for breathing, while waste from the habitat is piped into the GARDEN.

A few weeks on, the crew are hard at work conducting scientific experiments. The main purpose of the Mission to Mars is to gather as much information about the planet as possible. The crew are directed by experts on Earth via a radio link.

Scientists have already found out a great deal from unmanned probes and observer craft, but only a manned expedition can give them all the answers they need.

So far, no evidence of life, past or present, has ever been found. The crew have already travelled many kilometres to different locations on Mars, but they have not yet found any liquid water on the Martian surface. Liquid water is essential for life: without it, no living thing can exist. Will there be any liquid water under ground? Lev and Attiya set up a drilling rig to find out. Meanwhile, Dawei chips rock samples from a boulder. Gail thinks she may have spotted a fossil-like shape in a stone.



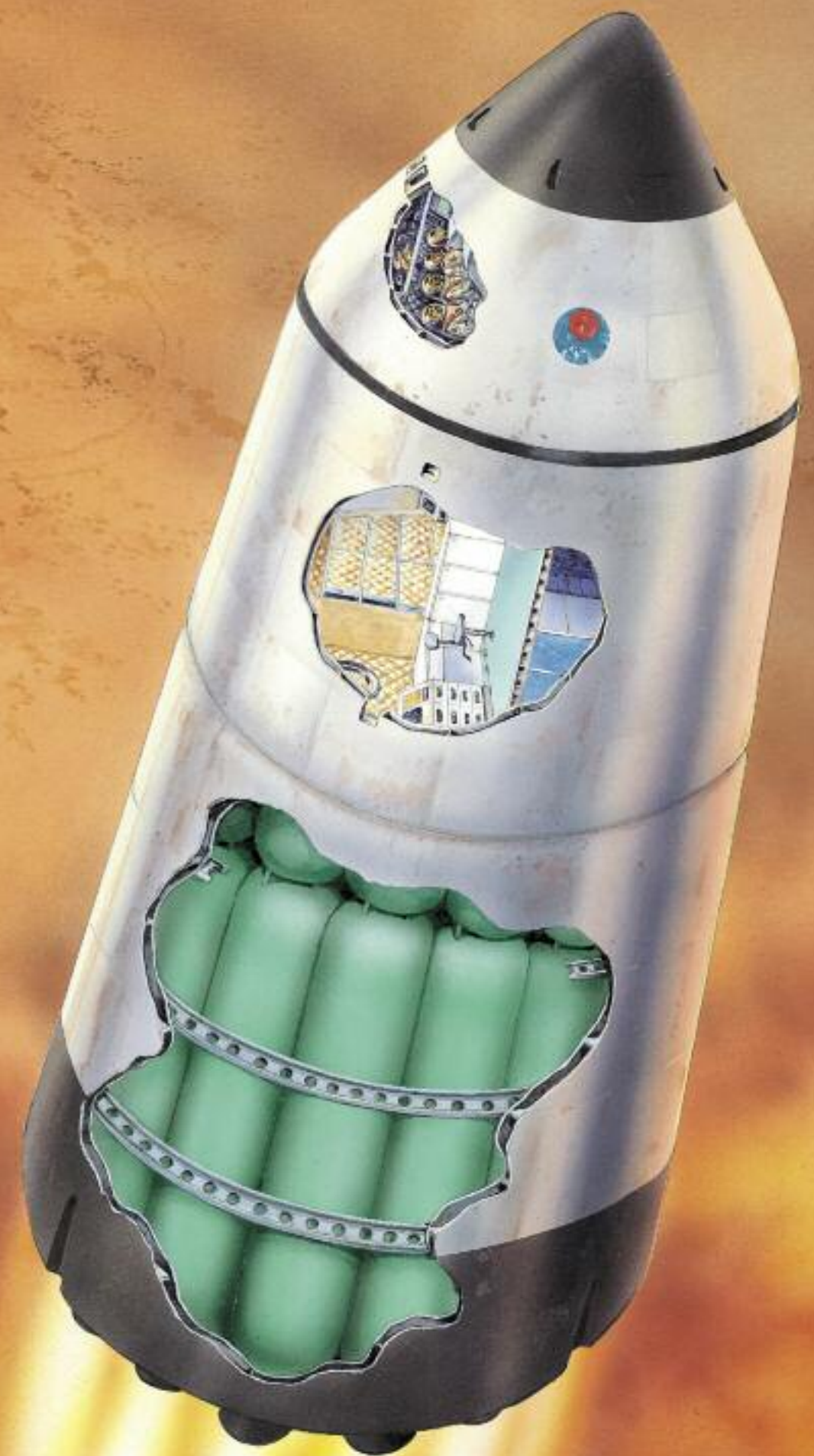
The astronauts have now spent 500 days on Mars. Although they have been living in a bleak desert, with only dust storms to break the eerie silence, they have

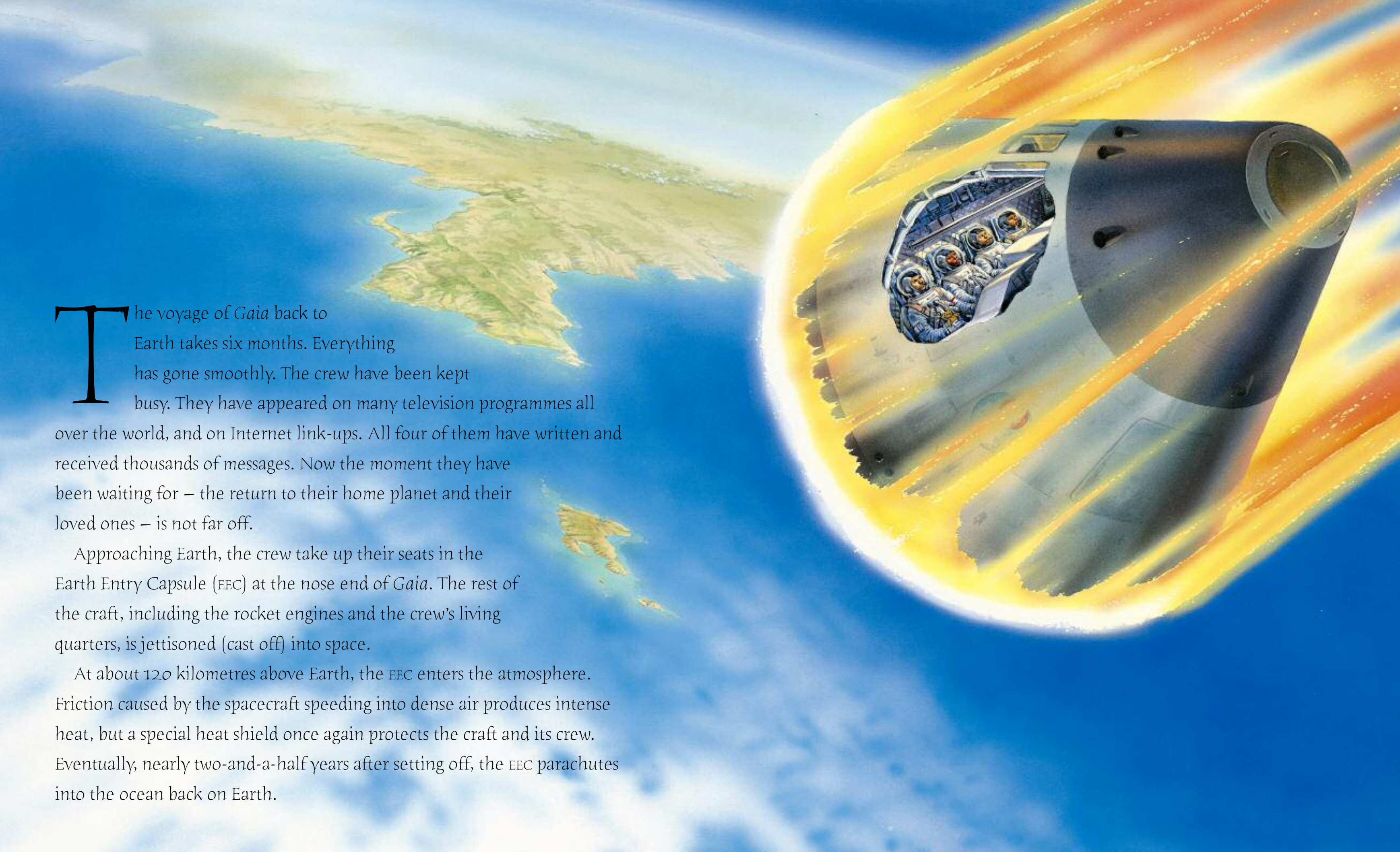
become quite fond of their temporary home. Now, however, it is time to return to Earth.

For the past few weeks, preparations have been made for what is the most dangerous moment in the whole mission, the ascent of their ERV from the surface.

Since the astronauts arrived, fuel for the ERV has been manufactured on Mars itself, by mixing hydrogen brought from Earth with carbon dioxide from the Martian atmosphere. The crew check that the level of fuel in the engines is sufficient to boost the spacecraft into orbit around Mars and off towards Earth. They also check that the on-board computer systems are working perfectly. Then they climb aboard the ERV, named *Gaia*, from the Greek word for Earth, and take up their positions in the command module.

Mission Control gives them the all-clear for lift-off. Lev activates the engines and *Gaia* blasts off. To every-one's relief, the ascent goes perfectly. The astronauts are on their way home.





The voyage of *Gaia* back to Earth takes six months. Everything has gone smoothly. The crew have been kept busy. They have appeared on many television programmes all over the world, and on Internet link-ups. All four of them have written and received thousands of messages. Now the moment they have been waiting for – the return to their home planet and their loved ones – is not far off.

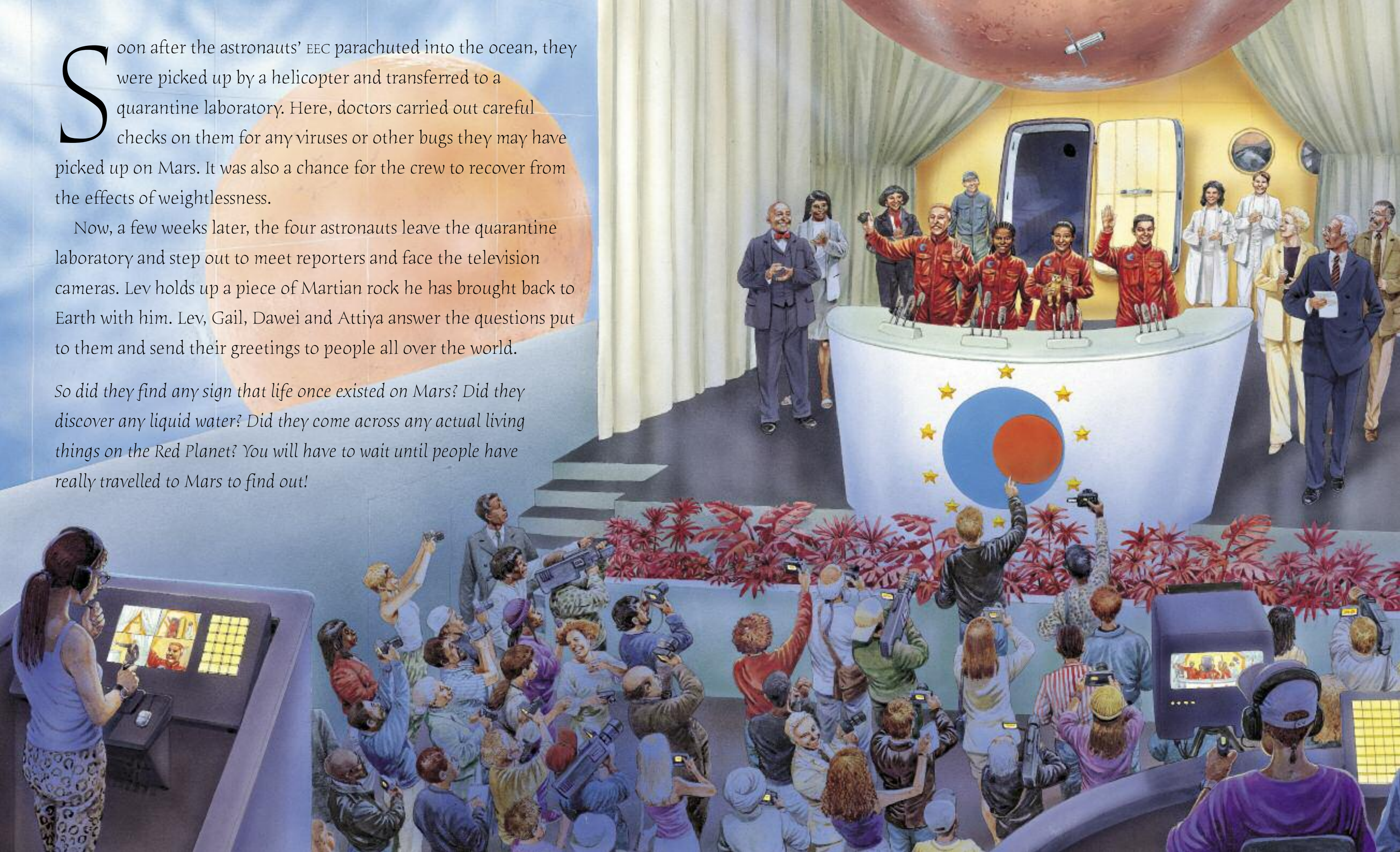
Approaching Earth, the crew take up their seats in the Earth Entry Capsule (EEC) at the nose end of *Gaia*. The rest of the craft, including the rocket engines and the crew's living quarters, is jettisoned (cast off) into space.

At about 120 kilometres above Earth, the EEC enters the atmosphere. Friction caused by the spacecraft speeding into dense air produces intense heat, but a special heat shield once again protects the craft and its crew. Eventually, nearly two-and-a-half years after setting off, the EEC parachutes into the ocean back on Earth.

Soon after the astronauts' EEC parachuted into the ocean, they were picked up by a helicopter and transferred to a quarantine laboratory. Here, doctors carried out careful checks on them for any viruses or other bugs they may have picked up on Mars. It was also a chance for the crew to recover from the effects of weightlessness.

Now, a few weeks later, the four astronauts leave the quarantine laboratory and step out to meet reporters and face the television cameras. Lev holds up a piece of Martian rock he has brought back to Earth with him. Lev, Gail, Dawei and Attiya answer the questions put to them and send their greetings to people all over the world.

So did they find any sign that life once existed on Mars? Did they discover any liquid water? Did they come across any actual living things on the Red Planet? You will have to wait until people have really travelled to Mars to find out!



THE MARTIAN LANDSCAPE

Mars is barren planet. The valleys and channels that cut across upland regions almost certainly once contained running water. From the evidence of sediments — muds and silts deposited by water — it seems probable that there were once rivers, lakes and even seas on Mars. Recent observations suggest that gullies on some steep slopes are being formed by the occasional rapid flow of liquid water at the surface. This may indicate the presence of underground water in a liquid state for at least some part of the Martian year. If it can be proved that water currently exists in liquid form under the ground, then it is possible that some kinds of life-forms might even inhabit the planet today.

The chief objective of a Mission to Mars is to find evidence of past or even present life on Mars, so a landing site must be chosen with this primarily in mind. It should lie in an area where scientists strongly suspect liquid water must once have collected on the Martian surface. The terrain must be level, and not be too difficult to roam across.

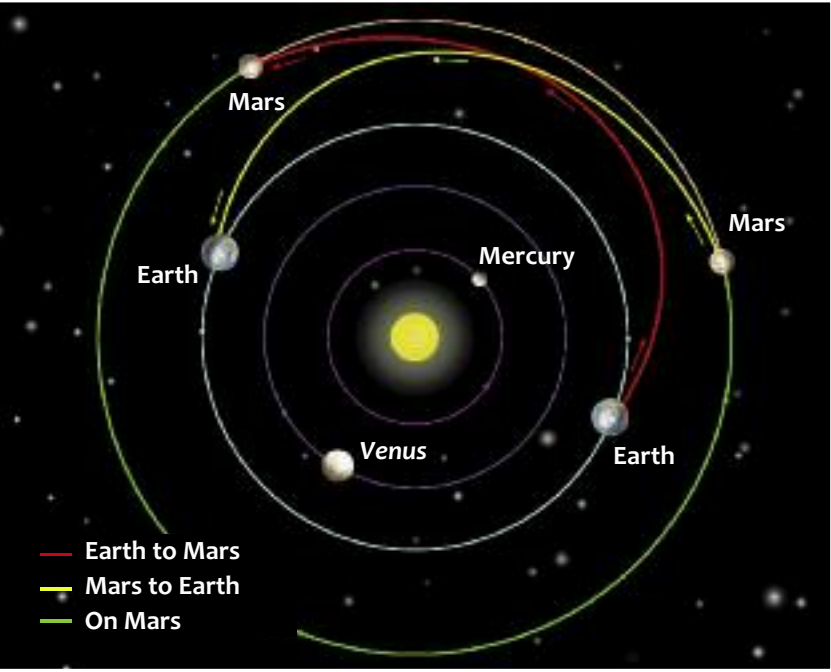
The Chryse Planitia is a low-lying plain in the equatorial region of Mars. A number of valleys lead into it, suggesting it once formed the floor of a large lake or ancient sea. Within a wide stretch of one of these adjoining valleys, Shalbatana Vallis, there is strong evidence of a former shoreline. A landing site near where the Shalbatana Vallis opens out on to the Chryse Planitia would therefore be an excellent choice for a mission base.

C H R Y S E C H A O S

In many areas on Mars, there is a jumble of ridges, cracks, hummocks, plains and valleys. This "chaos terrain" was created by the sudden release of large volumes of water across the surface.

Scientists are convinced that the shoreline discovered in the Shalbatana Vallis once belonged to an ancient lake. As it flowed into the lake, a river deposited sediments and divided into a number of smaller channels, forming a delta. The remains of this delta are visible today. Deltas on Earth are often muddy, marshy areas with an abundance of different plants and animals. Although Shalbatana Lake has long since dried up, there could also be fossil evidence of a past environment teeming with life.

C H R Y S E
P L A N I T I A



THE ROUTE TO MARS

As the spacecraft heads towards Mars from Earth, the positions of the planets change as they move around the Sun. (*above*). Lift-off from Earth is carefully timed so that the distance between the Earth and Mars is kept as short as possible. This reduces the risks from radiation on the astronauts as they travel through space. The crew spend 500 days living and working on Mars. After that time, Earth and Mars are once again favourably positioned for a short journey home.

GLOSSARY

Aerobraking A way of slowing down a spacecraft, by flying it into a planet’s atmosphere where the gases are denser than space. Friction slows the craft down.

Astronaut A person who travels in space.

Atmosphere The envelope of gases surrounding a planet, moon or star.

Booster A rocket engine that gives a spacecraft extra power at lift-off.

Canyon A deep gorge, often formed by water flowing through a dry landscape.



The twin rovers, Spirit and Opportunity, landed on Mars in 2004, and were still operating in 2011. Powered by solar panels, each rover was equipped with cameras and a robotic arm.

Cosmic rays High-energy radiation given off by distant objects in space.

Escape velocity The speed a spacecraft must reach in order to overcome the pull of Earth’s gravity: at least 40,000 km/h, or 10 times the speed of a rifle bullet.

PREVIOUS MARS MISSIONS



There have been more than 20 unmanned missions to Mars. Two US probes, Viking 1 and 2, were launched in 1975. The landing craft (left) sent back TV

pictures and tested soil samples. In the 2003 unmanned Mars mission, the small Mars Exploration Rover was sent out from the landing craft to study rocks at close quarters (right).



Fossil The ancient remains or traces of a once-living thing, usually found preserved in rock.

Friction A force that acts against the movement of one surface against another, creating heat.



Mars’ greatest volcanoes are found on the Tharsis Ridge, a bulge on its surface. One, Olympus Mons, at 27 km high, is more than three times as high as Mount Everest. The volcano’s base spans about 600 km.

Gravity The force that attracts all objects to each other. The larger the amount of matter an object contains, the greater its pull of gravity. Gravity is the force that keeps the planets orbiting the Sun.

Meteorite A lump of rock that falls from space to land on the surface of a planet or moon.



In 1996, researchers found what looked like a fossil microbe in a meteorite known to have come from Mars (above). The evidence is far from convincing.

Orbit The path followed by one object round another in space.

Planet A world that orbits a star. Planets do not radiate their own light, but reflect the star’s light.



The invention of the rocket engine allowed spacecraft to travel into space. In 1926 American scientist Robert Goddard (above) invented a rocket that burnt liquid fuel, used in later rocket launchers.

Radiation The creation and transmission of heat, light and other forms of energy through space.

Rocket engine An engine that produces a stream of hot gases by burning fuel inside tanks. Blasting hot gases out of the back of the engine pushes it forwards.

Satellite A spacecraft that orbits the Earth.

Solar panel A device that takes in energy from the Sun and changes it to electricity.

Space probe An unmanned spacecraft, guided from Earth. Some have passed close by, or landed, on the surface of other planets and moons.

Space station A permanent spacecraft, orbiting Earth, in which astronauts can carry out scientific research and experiments in space.

COLONIZING MARS?

One day, there may be permanent bases on Mars (right). Journeys to the Red Planet from Earth may become routine. Once people learn how to make the Martian environment easier to live in, whole towns and cities may eventually be built there in future years. And in the distant future, it may even be possible



for millions of people to leave Earth forever and travel vast distances across space in gigantic “star-ships” (left) to colonize a new planet.

