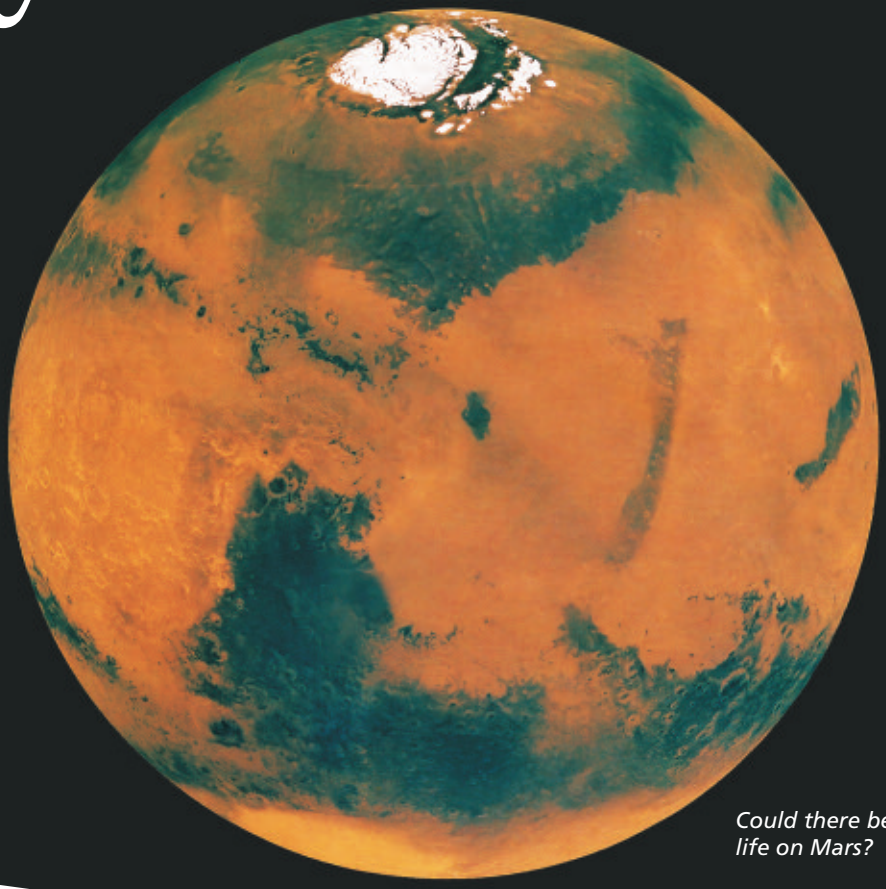
Life beyond Earth

MIKE FOLLOWS

Is there life elsewhere in the universe? Science fiction takes it for granted and scientists have found many different ways of looking for life out there. They are still looking!



Could there be life on Mars?

US Geological Survey/SPL

Here is the recipe for life on Earth:

- Liquid **water** is essential because it is the solvent in which biochemical reactions happen. Water is only liquid between its freezing and boiling points, that is between 0°C and 100°C.
- **Sunlight** provides the energy for life on Earth — but do other sources of energy exist?
- The element **carbon** is the basis of life on Earth. Each atom of carbon can bond with to up four other atoms. This leads to an almost infinite variety of compounds.

This recipe makes Mars an obvious candidate in the search for extraterrestrial life. It is the only other planet that orbits within the habitable zone — not so close to the Sun that water boils and not so far away that water is permanently frozen.

WHAT DO WE KNOW ABOUT MARS?

James Lovelock, famous for the Gaia hypothesis, made himself unpopular with NASA by suggesting that its *Viking* missions to Mars in 1976 were a waste of time and money. Looking at the spectrum of light from Mars allows astronomers to work out the composition of its atmosphere. The almost total absence of oxygen in the Martian atmosphere, shown in Table 1, led Lovelock to predict that the *Viking* missions would find nothing.

We don't know whether there are 'aliens' on Mars, but about 20 bits of rock chipped from the surface of Mars have landed on Earth as meteorites (Box 2). Speculation about life on Mars increased in 1996 when NASA scientists announced that the Martian meteorite ALH84001 contained fossils of bacteria.

Table 1 *The composition of our atmosphere compared to that of Venus and Mars*

	Venus	Earth, with life	Mars
Carbon dioxide (%)	96.5	0.03	95
Nitrogen (%)	3.5	79	2.7
Oxygen (%)	Trace	21	0.13

BOX 1 COMPARING ATMOSPHERES

Look at the figures in Table 1. There is no oxygen in the Martian atmosphere because it has reacted with iron to form iron oxide or rust on the Martian surface. This is why Mars looks red. In contrast, photosynthesis on Earth tops-up oxygen levels.

GCSE key words

Solar system
Respiration
Microwaves
Isotopes

Terrestrial comes from the Latin word *terra*, meaning earth, and is often used to describe life on Earth, especially that on land. *Extra* can mean outside or beyond so the term extraterrestrial means life beyond Earth.

- **Find out about the Gaia hypothesis.**

Is there any reason why we might doubt these data? The meteorite, which was found in the Antarctic, might have been sitting there for millions of years waiting to be discovered. There is a chance that one of our own (terrestrial) bacteria decided to live on ALH84001.

IS THERE EVIDENCE OF LIFE ELSEWHERE?

Microwaves are next to radio waves in the electromagnetic spectrum but have a shorter wavelength.

SETI (the Search for Extra Terrestrial Intelligence) seeks signals from extraterrestrials. It 'tunes in' to 1420 MHz in the microwave part of the electromagnetic spectrum. Microwaves are not absorbed much by interstellar gas and dust and the universe is very 'quiet' in the microwave part of the spectrum, so any signal would stand out. It is thought that other intelligent life would also know this and use microwaves to communicate. So far nothing has been detected.

GOING FOR A VISIT

We can send spacecraft to investigate likely planets. However, until we can find a quicker way of getting around, manned missions will be limited to our own solar system. Light takes 4 years to reach Alpha Centauri, the nearest star outside our solar system. This trip would take a spacecraft 12 600 years.

NASA sent two *Viking* spacecraft to Mars in 1976. They carried out experiments designed to look for evidence of photosynthesis and respiration. Robotic arms sampled Martian soil. Half the samples were kept as controls while a mixture of water and nutrients — 'chicken soup' — was added to the others.

BOX 2 METEORITES

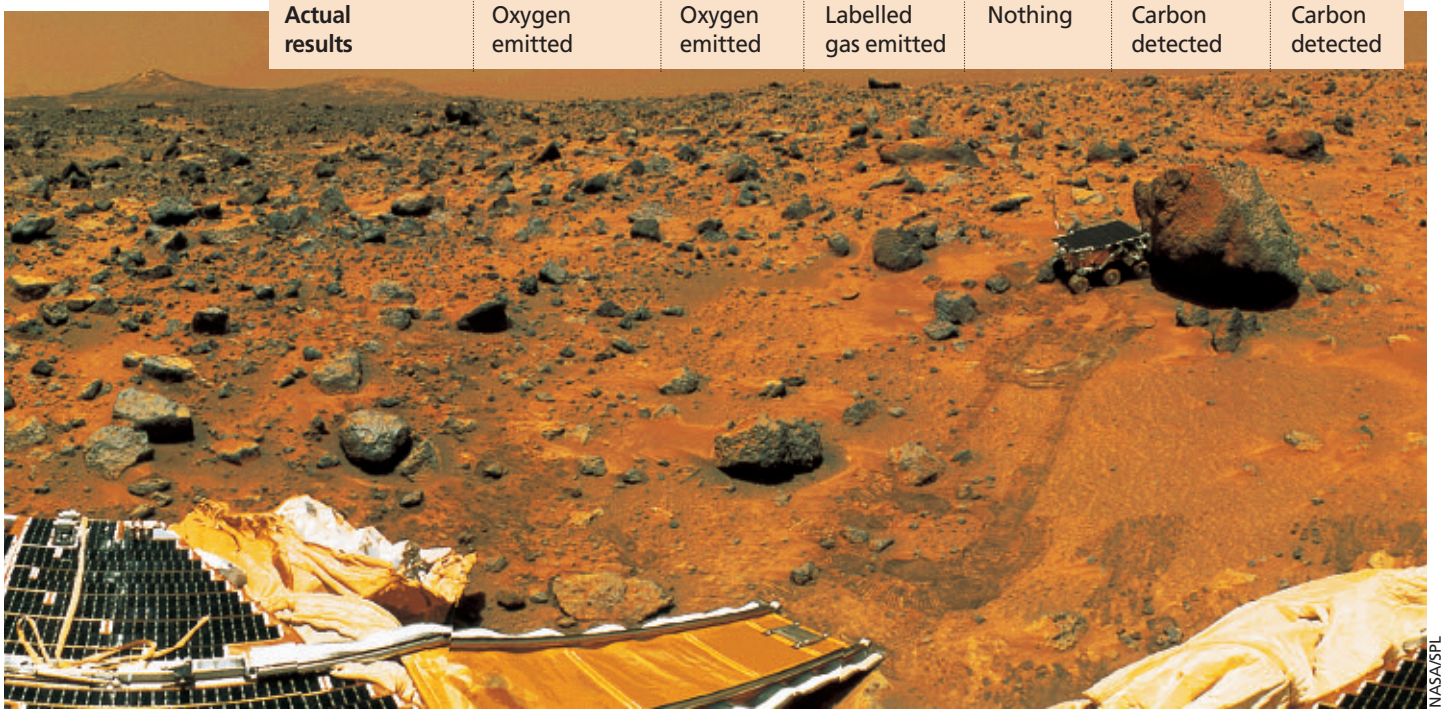
'Shooting stars' are really **meteors** — specks of rock that enter our atmosphere. They experience friction that generates heat and they burn up. We see them as streaks of light across the night sky. The few that reach the ground are called **meteorites**. Most meteorites come from the asteroid belt but scientists are studying about 20 that came from the Moon and a similar number from Mars.

Each meteorite is given a unique label. The letters state where it was found and the first two numbers give the year it was discovered. ALH84001 was the first meteorite (001) to be found in 1984 (84) in the Allan Hills ice-field in Antarctica (hence ALH).

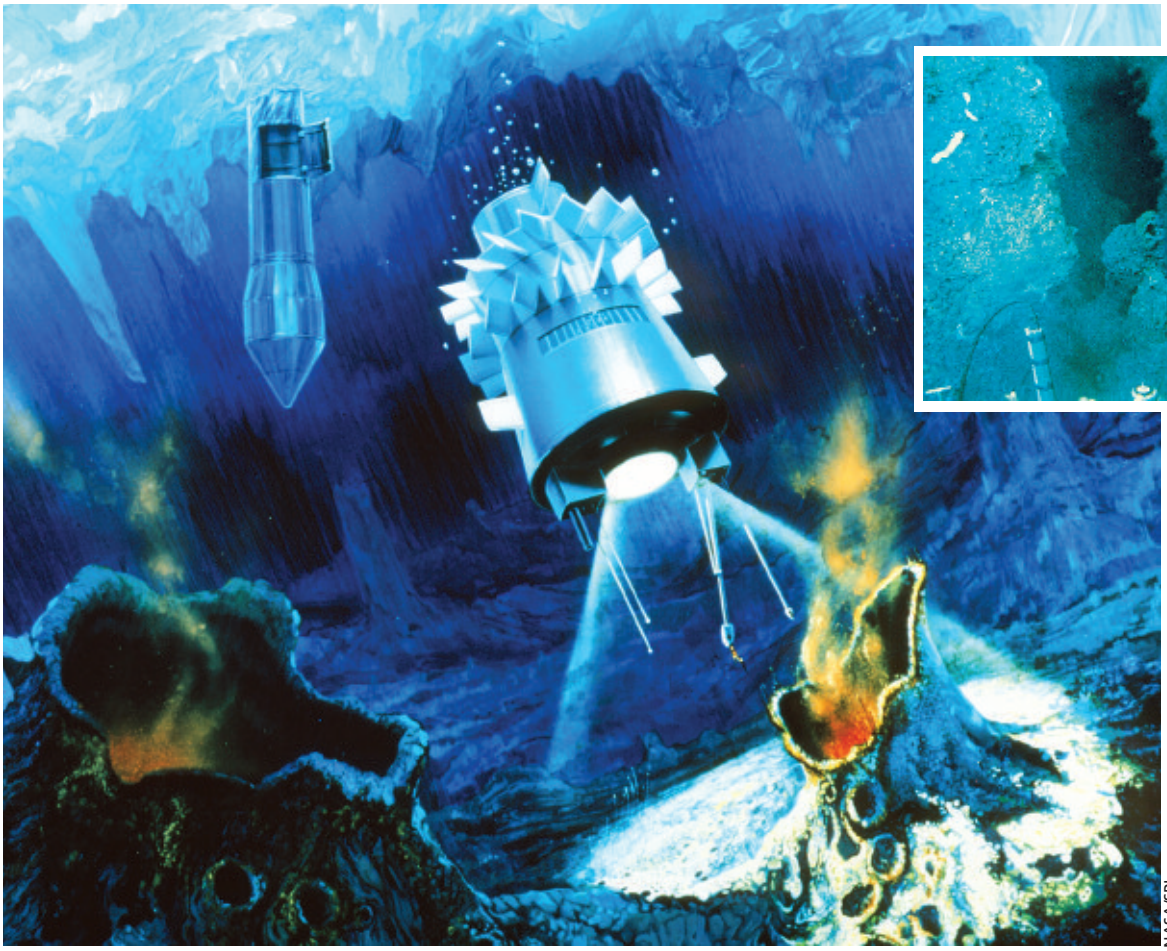
Table 2 *Results of the* Viking *experiments*

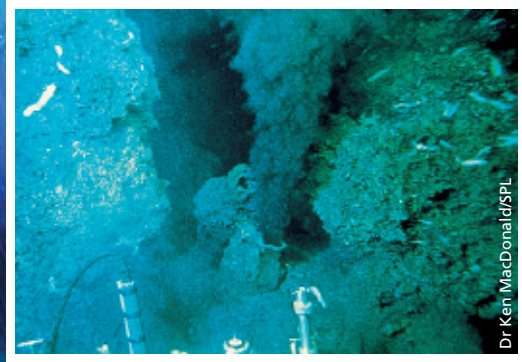
	GEX		LR		PR	
	Sample	Control	Sample	Control	Sample	Control
Results expected if there is life on Mars	Oxygen and carbon dioxide emitted	Nothing	Labelled gas emitted	Nothing	Carbon detected	Nothing
Results expected if there is no life on Mars	Nothing	Nothing	Nothing	Nothing	Nothing	Nothing
Actual results	Oxygen emitted	Oxygen emitted	Labelled gas emitted	Nothing	Carbon detected	Carbon detected

Below: *A robot investigating the surface of Mars after riding down the ramp from the lander (foreground) in a 1997 mission*



NASA/SPL





Above: *A 'black smoker' on the Earth's ocean floor, which supports life without sunlight*

Left: *An artist's impression of hydrobots being deployed beneath the ice of Europa*

The mix provided two of the three requirements for life. Several experiments were carried out:

- The GEX (gaseous exchange) experiment tested for evidence of respiration.
- In the LR (labelled release) experiment, chicken soup which had been 'marked' with carbon-14 was added to soil samples. This radioactive isotope of carbon was used as a tracer. The appearance of radioactive carbon dioxide was monitored to see if Martian life-forms had broken down the radioactive chicken soup.
- The PR experiment looked for microbes taking up radioactive carbon dioxide.

Look at the results of these experiments in Table 2. Would you conclude from these that there might be life on Mars? The tests appeared to detect respiration but the *Viking* mission did not find any organic molecules, let alone any creatures. In the end scientists rejected the evidence because it suggested that life forms could survive over too wide a range of conditions.

WIDENING THE SEARCH

In 1977, after the *Viking* missions, scientists discovered life in an unexpected place right here on Earth — next to hydrothermal vents called 'black smokers' at mid-ocean ridges (see CATALYST Vol. 11, No. 4).

These black smokers are several kilometres below the ocean surface, far deeper than light can reach. Life here cannot be driven by photosynthesis. So where does the energy come from? In a process called **chemosynthesis**, bacteria get energy from the chemical reaction between oxygen and hydrogen sulphide, which is emitted by the black smoker. Other creatures feed on the bacteria. Scientists now accept that starlight is no longer essential for life and are looking for life in places they had previously dismissed as too hostile.

The search for life is one of the reasons why an armada of spacecraft has been racing to rendezvous with Mars at the end of 2003. This includes Britain's *Beagle* 2 lander aboard the Mars Express spacecraft.

Scientists also have high hopes of discovering life on Europa, one of Jupiter's moons. They believe that it is like the Arctic, an ocean of liquid water covered in ice. The tidal energy from Jupiter is thought to prevent the ocean freezing and might provide the energy to sustain life. Scientists are already developing hydrobots which they plan to test in the Arctic.

Mike Follows *teaches science at Sutton Coldfield Grammar School for Girls, and is a part-time science writer.*

● For more about *Beagle* 2 and about the bacteria found on a Martian meteorite see 'Mars Express' in the previous issue of CATALYST (Vol. 14, No. 2).