Mars

Mars is the fourth planet from the Sun and the seventh largest in our solar system. It is situated, along with our planet, in the region of the solar system where liquid water can exist on the surface, and therefore there is a chance that life is (or once was) present on Mars.

Mars or the Greek term Ares is named after the Roman god of War. The planet probably got this name due to its red color (from the abundant iron oxide in the soil) and is therefore sometimes referred to as the Red Planet.

Its spinning period is almost identical to that of the Earth. Because its spinning axis is tilted with respect to the ecliptic plane by 24.5 degrees (similar to the tilt of Earth's axis) the surface of Mars experiences seasonal variations just like the Earth.

Mars is also made up of a core, a mantle and a thin crust. The interior of mars has been determined from data collected at the surfa ce. The data suggests that mars is made up of a dense core of approximately 700km radius, a molten rocky mantle denser than earths and has a thin crust. Data from Mars Global Surveyor indicates Mars' crust is about 80km thick in the Southern Hemisphere but it is only 35km thick in the Northern Hemisphere. Mars' low density suggests that te core is made up of large amounts of sulphur and iron.

Is Water needed for life to exist?

We have always been fascinated with the Red Planet, and we've wondered — in science fiction, in classrooms, in living rooms, and in laboratories—if anything lives there.

Water is the key to many important scientific questions when dealing with Mars. As far as we know, water is vital to the existence of life on any planet. According to Gene McDonald at the Astrobiology Research Element at NASA's Jet Propulsion Laboratory (JPL), water has unique properties that make it the best solvent for the kind of chemistry you need to start and sustain life. Neither ice nor water vapour will do. Biochemistry requires molecules to move around, which they can't do nearly as well in a solid. In vapour, it's hard to keep parts together on a molecular level. Knowledge of the amount and location of water on Mars is necessary to determine the question of whether life does or did exist on Mars.

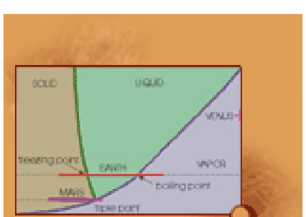

Figure 4.1
Enlarge image.

Scientists don't expect to find liquid water currently on the surface of Mars. This is because the thermodynamic (i.e., the temperature and pressure) conditions on Mars at present do not allow liquid water to exist.

There is no question that vapour and solid water do exist on Mars because they can be detected within the Martian atmosphere and in the polar ice caps. It is also possible that water may exist in solid form beneath the surface.

Past and current photographs demonstrate flow features such as drainage systems, floods and gullies. These flow features can only have been produced by liquid water some time in the past.

But, when did liquid water exist? Where has it gone? How long had it stayed on the Martian surface? These are questions that have yet to be resolved.

1. Drainage systems

On the extensive highlands many channels and valleys exist which are similar to the dendritic drainage systems on Earth. This image is no more than 50km long and 1km wide produced between 3.5 to 4.5 billion years ago.

There are two theories for the formation of drainage systems and channel formation.

1.1 The complex interconnected channels could have formed from repeated flooding caused by the melting of ground ice during volcanic eruptions.

1.2 Another theory is that the channels were created by runoff. If the atmosphere was denser and the surface temperature was higher than present then rain water could have existed and produced channels. Although this theory is not consistent with many observed channels that do not possess a dendritic structure. For example, unlike the drainage system on Earth, some Martian channels were isolated and others had large areas between branches that were not dissected. These channels could also appear sinuous and can be better explained by groundwater seepage.

From this picture the lack of dissecting terrain next to the channel is obvious but puzzling.

2. Floods and Gullies

As well as channels and drainage basins the evidence of large floods can also be found on mars (Figure 4.7) shows a satellite view of the 600km wide Tiu Valles. The flood originated at the bottom and flowed towards the top. You can see at the source the terrain is chaotic.

Flooding was so intense that it cut through ridges, and wrapped around craters to form tear-shaped islands.

Images obtained from the more recent Mars Global Surveyor mission show clearly that gullies exist on steep crater walls. Possibly formed by running liquid water. The source of the liquid water may have originated from frozen water within the layers (Figure 4.11) shows clearly the gullies and the layering along a sloping surface. In addition, high resolution images also revealed the many strange-looking layered terrain (Figures 4.13; 4.14; and 4.15). Are they the equivalent of the sedimentary layers on the ocean floors or lake beds on Earth? Further studies are necessary to determine these answers.

3. Polar Icecaps

Both Martian poles have ice caps that advance and recede with seasons. The seasonal cap consists largely of carbon dioxide ice, but the more permanent cap which remains during the summer is probably made of water ice, at least in the North Pole. There have been larger amounts of water found over the northern pole than the southern pole.

This picture shows the northern ice cap (Figure 4.16). It is ~1000km wide. The black lines are valleys or south facing escarpments free from frost as the high winds spiral out from the pole. Layering of dust and ice occurs due to the seasons which maintains a a record of climate variations during the recent geological past.

The southern pole is much smaller and always covered in frost

There may also be water ice hidden below the surface at lower latitudes. The seasonal changes in the extent of the polar caps changes the global atmospheric pressure by about 25% (as measured at the Viking lander sites).

ALH84001 - The Life on Mars meteorite

On August 7, 1996, an historic press conference was held at NASA Headquarters in Washington DC. News that scientists had found evidence of life in a Mars meterorite had leaked out,

The meteorite was catapulted away from Mars fifteen million years ago when a huge comet or asteroid impacted the surface. The meteorite travelled through space for millions of years and then encountered the Earth. It entered Earth's atmosphere about thirteen thousand years ago and landed in Antarctica. The meteorite lay there until 1984, when a team from the NASA Johnson Space Center found it while exploring the Allan Hills ice field, and took it back to Houston. At the press conference, several scientists from NASA and Stanford University announced their findings -- they confirmed that they had found evidence of ancient, fossilized, microscopic life from a Martian meteorite, known as ALH84001.

The evidence for life

The indication of life is based on three important pieces of evidence, all discovered within mineralized fractures within a few hundred-thousandths of an inch. One is the discovery of abundant polycyclic aromatic hydrocarbons (PAHs) on the fracture surfaces. These are a family of complex organic molecules which are commonly found on dust grains and certain types of meteorites in outer space, presumably formed by non-biological chemical reactions. However, when micro-organisms die they break down into PAHs as well. The mixture of PAHs found on ALH84001 is very different from that found on dust grains and other meteorites, suggesting the possibility of a biological origin. Thousands of different types of PAHs are found all over the Earth, but those in ALH84001 do not appear to be contaminants which have leaked into the meteorite.

Another line of evidence involves unusual mineral phases found beside the PAHs. These carbonate minerals form "globules" about 50 micrometers across, some of which have cores containing manganese and rings of iron carbonate and iron sulfides, and also contain magnetite. These minerals bear strong resemblance to mineral alterations caused by primitive bacteria on Earth. This diversity of minerals in such a small area, formed under the presumed conditions, seem to make a non-biological origin unlikely.

Finally, high-resolution scanning electron microscopy has revealed the presence of tiny "ovoids" which may actually be fossil remnants of tiny (20 to 100 nanometer) bacteria.

However, much work will be done on this in the future, including searching for amino acids, other fossil structures such as cell walls, other types of fossils, and fossils of bacteria frozen in the act of reproducing.

Mars is almost certain to have been warmer and wetter in its distant past, so the existence of primitive life has been a tantalizing possibility for some time, but the real search may be just beginning.

So what if there is life on mars?!

If life on Mars does exist (or have existed at some point in time), it would mean that the creation of life is not something that happens because of freak chance, but is in fact a probable occurance given the right conditions.

Space agencies including NASA, ESA (the European Space Agency), and the Japanese Space Agency are even now sending the latest in a series of spacecraft to learn more about Mars and to look for evidence of water and life. In 2005, a **Mars Sample Return** mission will attempt to bring back likely candidate samples of minerals in which these kind of fossils would occur.