Is there life on mars?

In order to conclude whether a life-form can exist on Mars, much research must be done in order to gain an understanding of its atmosphere, surface, nutrients and minerals available to possible biological life-forms on the planet. Mars is the fourth planet in our Solar System and is known as the Red Planet due to iron oxide found on the surface. Having been studied for decades, Mars shows the most suitable conditions, of all the planets in our solar system, for our presumptions of evolution of life (Klein, Lederburg et al. 1976). There has been much evidence put forward contributing to the theory of a biological life-form on Mars, the most documented and well known of which being the study of the meteorite ALH 84001. This meteorite was believed to have been projected from the surface of Mars around 16 million years ago and landed in Antarctica 13, 000 years ago(Frankel & Buseck, 2000). The 2kg carbonaceous meteorite studied by McKay et al. contained globules of chemicals and also contained bacterial-shaped objects which resembled fossilized terrestrial microorganisms, ranging from 10-100nm long (McKay, et al., 1996).

It is believed by many that there are too many factors such as UV radiation and extreme temperature environments which could inhibit a life-form on Mars. Although the distance from Earth to the Sun is considerably less than that of the Sun to Mars, our atmosphere protects living organisms on Earth. Studies have shown that an atmosphere is present on Mars through the identification of an insignificant ozone layer, however this atmosphere is not the most suitable for living organisms but unlikely to be a life limiting factor (Cockell, et al., 2000). Some arguments which both oppose and agree with the theory of extra-terrestrial life include studies carried out by the Viking

Explorers and MER programmes which landed on Mars. These man-made devices studied the atmosphere and the top layer of soil to discover a very high oxidation factor which could inhibit growth by converting living matter to CO^2, as well as studying sedimentary rocks on the surface of the planet. The search for life on Mars shows interesting differences in both personal theories and scientific studies.

Panspermia is the theory that living organisms can be transported throughout the Universe, travelling in meteorites. The theory was first proposed by Arrhenius who believed that living bacteria could be transported through space, and therefore believed this was the reason for the beginning of life on Earth (Tepfer, 2008). These meteorites are projected from the surface of plates through collisions of boulders and/or planets in the Solar System. Many meteorites have landed on Earth from Mars, including ALH 84001, NWA 1195, NWA 2046, DaG 476 and the latest NWA 2626. The most famous of these meteorites is ALH 84001 which shows evidence of a life-form embedded in the meteorite. The theory of Panspermia can be justified by a study carried out by D. Stöffler et al.. The range of pressures observed in Martian meteorites range between 5 and 50 GPa. Bacterial spores, cyanobacteria and lichens (all of which appear to be embedded in the meteorite ALH 84001), were exposed to this range of shock pressure. The study revealed that bacterial spores and lichens could withstand the pressure up to 45 GPa while cyanobacteria was killed at 10 GPa. This study implies the potential for transfer of life throughout the Universe from one planet to another(Stöffler, et al., 2007).

Analyses and Results of the Martian Meteorite ALH84001

Analysis of the meteorite show results which support and oppose the hypothesis of extra-terrestrial life to be found on Mars (Gibson, et al., 2001). The meteorite, which was studied by McKay et al, showed evidence of an extra-terrestrial life-form embedded in the rock. There were globules of Ca, Mg and Fe carbonate minerals which are believed to have been distributed by a biological factor. It is believed by McKay et al. that these globules were formed at low temperature. Otherwise high temperature (over 118°C) would have killed any bacteria which are believed to have formed these globules. However, others who oppose the theory of extra-terrestrial life, believe that these globules may have been distributed by a non-biological factor which renders this piece of evidence quite unreliable. There were other factors noted which shows the possibility of extra-terrestrial life: Polycyclic aromatic hydrocarbons (PAH) were observed and showed a different distribution than that of terrestrial PAH’s. Another factor observed was bacteria-shaped objects found on the surface of the meteorite, which resemble fossilized terrestrial micro-organisms, up to 100µm long (Frankel & Buseck, 2000). Some of the bacteria shaped objects are however extremely small in size which range from 20-100nm. This piece of evidence is ridiculed by some scientists, in which they declare that these tiny objects resemble artifacts in the meteorite (Bradley, et al., 1996).

http://www. lpi. usra. edu/lpi/meteorites/s9612609. gif

Bacteria shaped objects on Martian meteorite, Allan H. Treiman, Lunar and Planetary Institute.

The Viking and MER Missions

The first Viking mission was launched in the summer of 1976. It consisted of two orbiters, which had a main objective of photographing the planet from orbit, and two landers, which studied the surface of the planet. The main emphasis was on photography, in which orbiter 1 produced over 10, 000 pictures, taken from the planets orbit(Snyder & Evans, 1981).

In 2003, two rovers were launched, called Mars Exploration Rovers. The objective of this mission to Mars was study and to determine whether Martian conditions and it's atmosphere could support the theory of a possible life-form having ever existed on the planet (Squyres & Knoll, 2005). The MER missions include the Rovers; Spirit and Opportunity which carried out surveys and analyses on the surface of Mars.

File: NASA Mars Rover. jpg

Rover Opportunity, Maas Digital LLC for Cornell University and NASA/JPL

The two Rovers covered specific regions known as Gusev and Meridiani Planum respectively for over a year and a half. The Rover Opportunity landed on the surface of Mars on January 24th and travelled through two craters (Eagle and Endurance) while carrying out experiments on both craters.

Experiments and Results from Viking and MER programmes

Aerosols and water vapour were detected in the Martian atmosphere by the Viking orbiter and other scientific research objects, which included: Mars Global Surveyor (MGS), Mars Atmospheric Water Detector (MAWD) and Thermal Emissions Spectrometer (TES). This water vapour was detected in

the North Polar region during Spring and Summer seasons. MAWD detected twice as much vapour in the region than any of the other orbiters (Pankine, et al., 2009). The detection of water in the Martian atmosphere contributes a large amount of evidence to support the theory of a suitable atmosphere for a biological life-form to exist.

Hematite was discovered on the surface of the planet, by the rover Opportunity, in the Meridiani Planum. This mineral form of iron-oxide is a possible preservative for pre-biotic and biotic processes carried out on the surface of Mars. These processes are carried out on Earth in rock varnishing, in which micro-colonial fungi and bacteria are present in rock varnish matrices, which were documented in America and Australia (Allen, et al., 2004). It is believed that water did once flow on the surface of Mars through the discovery of rippled like curves, indicating that streams once flowed through the Meridiani Planum (Horneck).

Ancient, sedimentary rocks were also found at Meridiani plain by the Rover Opportunity, which consist of sandstone composed of sand grains which consisted of a variety of sulphate salts formed by erosion and re-deposition (Squyres & Knoll, 2005). One of the most important findings of the mission however was a record of aqueous processes found on the Meridiani plain both in surface and sub-surface regions. Although these aqueous processes were identified, there is still no record of liquid water on the surface of Mars. Any water present on Mars, is found in the atmosphere as water vapour, located at the north Polar region.

UV Radiation:

Because of a thin atmosphere and an insignificant ozone layer, the surface of Mars is exposed to high UV radiation, which includes UVA, UVB and UVC. UV radiation is known to be a cause of DNA damage and mutation in bacterial species and also more developed life-forms. UV radiation is also known to inhibit photosynthesis in plants. Life-forms on Earth contain processes that protect them from exposure to UVA radiation. However, because of high UVB and UVC radiation exposure to the Martian surface, and also conditions such as extreme temperature changes and a lack of liquid water on the surface, it is unknown for any life-form to withstand such conditions(Cockell, et al., 2000).

In order to understand and examine bacterial behaviour under exposure to this high UV radiation, an experiment was carried out by Scheurger et al.. Seven different Bacillus spp. were exposed to conditions similar to that of the Martian surface. The Bacillus spp. were exposed to the radiation in time sets of 0, 0. 25, 0. 5, 1, 5, 15, 30, 60, 120 and 180 minutes. The bacteria were prepared for the experiment as thin monolayers of endospores. The results showed that B. pumilus SAFR-032 (surviving for 180 minutes) was the most resistant to the Martian conditions, while B. megaterium and B. subtillis 42HS-1 (which were inactivated after 30 minutes) were the least sensitive under exposure of high UVB and UVC radiation.

Conclusion

It is very difficult to conclude whether or not life does or even did exist on the surface or in the Martian atmosphere. Evidence from both sides of the theory are being analysed in extreme detail in order to come to a conclusion.

The analyses and study of the Martian meteorite ALH84001, is considered the most studied and detailed analyses ever to be carried out on an igneous rock. Even with this extent of analyses being carried out on the meteorite, we still cannot come to a clear and concise conclusion to whether or not it contained traces of extra-terrestrial life. Although the detection of carbonate globules and bacterial shaped objects suggests that life theoretically could have existed on the planet of Mars, scientists who oppose the theory of extra-terrestrial life disagree that these discoveries indicate a life-form present in the meteorite. They suggest that because of the small size of these bacterial-shaped objects that they could represent artifacts in the meteorite.

There was also some criticism about the Viking and MER missions. Although a small amount of atmospheric water vapour was observed, the lack of liquid water on the surface declares this evidence inconclusive. However there was some very interesting discoveries made by the Rover Opportunity, including the detection of hematite. This mineralised form of iron-oxide can be used for the preservation of aqueous processes. This discovery, along with the discovery of ripple-like curves in the Meridiani plain, could indicate a past life-form having existed on the surface of the planet many years ago.

I believe that an extra-terrestrial, biological life-form could have existed on the surface of Mars, in past decades or even centuries. Evidence from both the Mars Exploration missions and the study of the Martian meteorite, ALH84001, provide much contribution to the theory that life did exist on the planet in the past. It is clear that life cannot survive in the Martian atmosphere at present because of extreme conditions. The exposure to high

UV radiation, extreme temperature changes and also a lack of liquid water on the surface indicate to me that these conditions are not only unfavourable to the survival of a life-form but are far too extreme for a biological life-form to survive for a significant time frame.

In relation to the theory of Panspermia, I believe that it can be justified by the experiment carried out by D. Stöffler et al.. If the bacteria shaped objects found in the meteorite prove to be biological life-forms this piece of evidence could explain another widely investigated theory of where and when life began on Earth. Through the study and analyses of Mars and its atmosphere, I believe that many of the questions and theories about life on Earth can be answered.