LIFE ON MARS?

A group of scientists led by David McKay of NASA's Johnson Space Center has published an article in the August 16 issue of Science magazine announcing the discovery of evidence for primitive bacterial life on Mars. An examination of a meteorite found in Antarctica and believed to be from Mars shows:

1) hydrocarbons which are the same as breakdown products of dead microorganisms on Earth

2) mineral phases consistent with by-products of bacterial activity, and

3) tiny carbonate globules which may be microfossils of the primitive bacteria, all within a few hundred-thousandths of an inch of each other. Based on age dating of the meteorite, the following scenario has been proposed:

1. The original igneous rock solidified within Mars about 4.5 billion years ago, about 100 million years after the formation of the planet. (Based on isotope ages of the igneous component of the meteorite)

2. Between 3.6 and 4 billion years ago the rock was fractured, presumably by meteorite impacts. Water then permeated the cracks, depositing carbonate minerals and allowing primitive bacteria to live in the fractures.

3. About 3.6 billion years ago, the bacteria and their by-products became

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fossilized in the fractures. (Based on isotope ages of the minerals in the fractures)

4. 16 million years ago, a large meteorite struck Mars, dislodging a large chunk of this rock and ejecting it into space. (Based on the cosmic ray exposure age of the meteorite)

5. 13,000 years ago, the meteorite landed in Antarctica.

6. The meteorite, ALH84001, was discovered in 1984 in the Allan Hills region of Antarctica.

How do we know the meteorite came from Mars?

Meteorite ALH84001 is a softball-sized igneous rock [ALH84001] weighing 1.9 kilograms (4.2 pounds). It is one of twelve meteorites discovered on Earth which are thought to be from Mars. Most meteorites formed early in the history of the solar system, some 4.6 billion years ago. Eleven of the twelve martian meteorites have ages less than 1.3 billion years, ALH84001 at 4.5 billion years old being the only exception. All twelve are igneous rocks crystallized from molten magma in a way which suggests they formed in a planetary-sized body, not an asteroid. They have similar oxygen isotope characteristics to each other and higher concentrations of ferric iron, water, and other volatiles than other meteorites. All twelve also show evidence of shock heating, presumably as a result of the impact which ejected them into space. Gas bubbles trapped in one meteorite, EETA79001, have a composition which matches the current martian atmosphere as measured by the Viking Landers, compelling evidence that this meteorite and by association the others, including ALH84001, came

from Mars.

The evidence for life

The indication of life hinges on three important pieces of evidence, all discovered within mineralized fractures in the meteorite in close proximity to each other. 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 and pyrrhotite. 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.

[Mars Microfossils?] 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. If so, they are 100 times smaller than

any bacteria microfossils found on Earth, except for some supposed “nanofossils” recently discovered in very young terrestrial rocks, a finding currently not generally accepted as fossil organisms.

Taken together, the findings are thought to be strong evidence pointing to primitive bacterial life on Mars. The PAHs, unusual mineral phases, and “microfossils” were all located within a few micrometers of one another, indicating a relationship which may require a biological explanation. 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.

Source: NASA