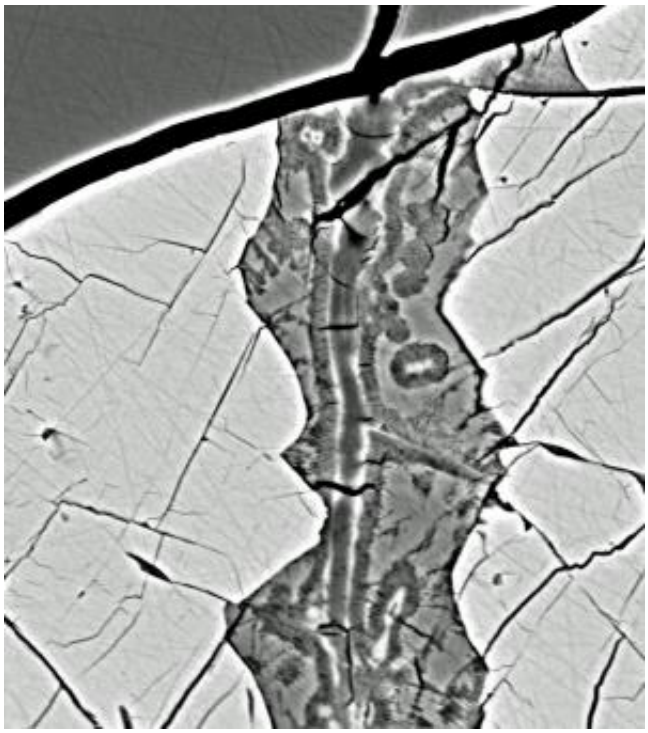
Meteorites reveal warm water existed on Mars

15 November 2012



This is an Electron Microscope image of the Lafayette meteorite (NHM sample BM 1959, 755). It shows the hydrous vein with carbonate and clay deposited by water at up to 150 oC on Mars due to an ancient impact. The field of view is 50 microns. Credit: University of Leicester

New research by the University of Leicester and The Open University into evidence of water on Mars, sufficiently warm enough to support life, has been published this week in the journal *Earth and Planetary Science Letters*.

The study determined that water temperatures on the Red Planet ranged from 50°C to 150°C. Microbes on Earth can live in similar waters, for example in the volcanic thermal springs at Yellowstone Park, the scientists behind the research point out.

The research is based on detailed scrutiny of Mars meteorites on Earth using powerful microscopes in the University of Leicester Department of Physics and Astronomy. This was followed-up by computer modeling work at The Open University.

Dr John Bridges, Reader in Planetary Science in the University of Leicester Space Research Centre and Lead Author, said: "Rovers on Mars – the Mars Exploration rovers Spirit and Opportunity, and the Mars Science Laboratory rover Curiosity – are studying rocks to find out about the geologic history of the Red Planet. Some of the most interesting questions are what we can find out about water, how much there was and what temperature it might have had.

"While the orbiters and rovers are studying the minerals on Mars, we also have meteorites from Mars here on Earth. They come in three different groups, the shergottites, the nakhlites and the chassignites. Of most interest for the question of water on Mars are the nakhlites, because this group of Martian meteorites contains small veins, which are filled with minerals formed by the action of water near the surface of Mars."

Dr. Bridges and his group studied those alteration minerals in great detail. Altogether eight nakhlite Martian meteorites are known, and all have small but significant differences between them and in their alteration minerals.

Lafayette is one of them; and the most complete succession of newly formed minerals can be found in its veins (see figure). Careful investigations of the minerals with an electron microscope and a transmission electron microscope have revealed that the first newly formed mineral to grow along the walls of the vein was iron carbonate. The carbonate would have been formed by CO2-rich water around 150°C. When the water cooled to 50°C, it would have formed the clay minerals, which were then followed by an amorphous phase that has the same composition as the clay.

Microbes use the reactions during mineral formation to gain energy and elements essential for their survival.

Dr Bridges added: "The mineralogical details we see tell us that there had been high carbon dioxide pressure in the veins to form the carbonates. Conditions then changed to less carbon dioxide in the fluid and clay minerals formed. We have a good understanding of the conditions minerals form in but to get to the details, chemical models are needed."

Dr Susanne Schwenzer, Postdoctoral Research Associate in the Department of Physical Sciences at The Open University who previously studied Martian meteorite compositions, said: "Until John's study was finished, I used the findings from orbiters around Mars, and modelled each of the new minerals individually. Those orbiters have found clays on the surface of Mars, but the spatial resolution is very different from the detailed study achieved in the nakhlites. Before we had the detailed study of the nakhlite meteorites, we did not know that carbonates are forming first, followed by the clays. Therefore I was very excited to see the details of the new mineralogical study."

By combining data from both universities, researchers were able to predict water conditions on Mars. Initially, the water was around 150°C and contained a lot of CO2, forming the carbonates, then cooled to about 50°C, thus forming the clays.

"The driving force heating the water might have been an impact into the Martian surface." Dr. Bridges explains. "And you only have to look at a map of Mars to see how numerous those are on the Martian surface," Dr. Schwenzer adds.

More information: Bridges J.C. and Schwenzer S.P. The nakhlite hydrothermal brine on Mars. *Earth and Planetary Science Letters* 359 (2012) 117.

Provided by University of Leicester

APA citation: Meteorites reveal warm water existed on Mars (2012, November 15) retrieved 1 March 2021 from https://phys.org/news/2012-11-meteorites-reveal-mars.html

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